

Around 1000 B.C. the Chinese began piping natural gas in bamboo lines that extended a mile or more and provided fuel for salt production. Bamboo gas-lines are still in use in the Szechwan salt industry. (From a photo of the American Gas Association.)

tiny hut, big enough for the smallest twig-sized stove, a few tools, a book or two, a shelf for potting plants—or else make just a 3-foot thatch roof, without walls or with waist walls woven of wasted branches from your grove, room enough for you and a flute or poem to rest together a moment, half-sheltered, half-exposed.

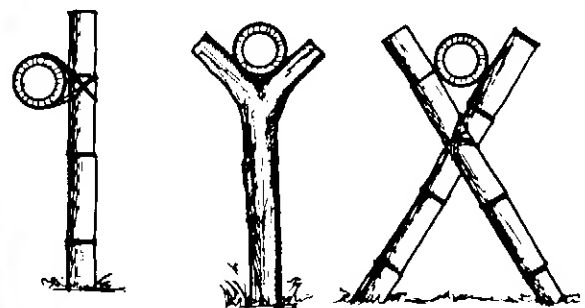
PIPES. “Bamboo pipe, easy to make with unskilled labor and local materials, is extensively used in Indonesia to transport water to villages. In many rural areas of Taiwan, bamboo is commonly used in place of galvanized iron for deep wells up to 150 meters [500 feet]. Bamboos of 50-mm [2-inch] diameter are straightened by means of heat, and the inside nodes knocked out. The screen is made by punching holes in the bamboo and wrapping that section with a fibrous matlike material from a palm tree, *Chamaerops humilis*. In fact, such fibrous screens are also used in many galvanized iron tube wells. *Tools and materials:* chisels, nail, cotter pin or linchpin, caulking materials, tar, rope.

“Bamboo piping can hold pressure up to 2 atmospheres (about 2.1 kilograms per square centimeter or 30 pounds per square inch). It cannot, therefore, be used as pressure piping. It is most suitable in areas where the source of supply is higher than the area to be served, and the flow is under gravity.

“*Health aspects:* With piping for drinking water, the preservative treatment recommended is to immerse green bamboo completely in a solution of 95 percent water and 5 percent boric acid: borax. After a bamboo pipe is put into operation, it gives an undesirable odor to the water. This, how-

ever, disappears after about three weeks. If chlorination is done before discharge to the pipe, a reservoir giving sufficient contact time for effective disinfection is required since bamboo pipe removes chlorine compounds, and no residual chlorine will be maintained in the pipe. To avoid possible contamination by groundwater, an ever-present danger, it is desirable to maintain the internal pressure within the pipe at a higher level than any external water pressure outside the pipe. Any leakage will then be from the pipe, and contaminated water will not enter it.

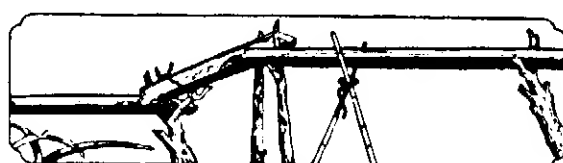
“*Design and construction:* Bamboo pipe is made of lengths of bamboo of the desired diameter by boring out the dividing membrane at the joints. A circular chisel for this purpose is shown. One end of a short length of steel pipe is belled out to increase the diameter, and the edge is sharpened. A length of bamboo narrow enough to slide into the pipe is used as a boring bar and secured to the steel pipe by drilling a small hole through the assembly and driving a nail through the hole. This nail is also



Support systems for bamboo pipe.



Bamboo aqueduct depicted in a carved wood ramma (Japan, c. 1880). The ramma is a decorative panel that gives expression to the exacting tool control of Japanese craftsmen.



known as a cotter pin or linchpin. Three or more chisels ranging from the smallest to the maximum desired diameter are required. At each joint the membrane is removed by first boring a hole with the smallest diameter chisel, then progressively enlarging the hole with the larger chisels.

"Bamboo pipe lengths are joined in a number of ways. Joints are made watertight by caulking with cotton wool mixed with tar, then tightly binding with rope soaked in hot tar. Bamboo pipe is preserved by laying the pipe below ground level and ensuring a continuous flow in the pipe. Where the pipe is laid above ground level, it is protected by wrapping it with layers of palm fiber with soil between the layers. This treatment will give a life expectancy of about three to four years; some bamboo will last five to six years. Deterioration and failure usually occur at the natural joints, which are the weakest parts. Where the depth of the pipe below the water source is such that the maximum pressure will be exceeded, pressure relief chambers must be installed. These chambers are also installed as reservoirs for branch supply lines to villages en route."³²

Efforts to apply the information above are reported in a leaflet from Africa: "Bamboo Piping: An Experiment in Mezzan-Teferi, Ethiopia." (See Christian Relief and Development Association in Bibliography.) "The authors did not have much success with a circular punch tool for knocking out the inner dividing walls of the bamboo. They developed a simple drilling bit which can be easily made by a blacksmith [drawings and photos are provided]. With this tool three workers could easily bore out twelve 7-meter bamboo poles in one hour. The experimenters also developed a unique joint sealing system in which soaked cowhide is wrapped around the joint twice and sealed tight with two pieces of galvanized wire . . . Pipes carried water for irrigation and domestic use."³³

"The tested crushing strength of bamboo used

for water pipes has been determined to be approximately 766 pounds per lineal foot for 3½-inch-diameter canes. Two-inch-diameter canes will withstand a pressure of 374 pounds to the lineal foot. Clay tile measuring 3½ inches in diameter has a crushing strength of only 276 pounds."³⁴ See also Lippert (1976) and Herrera's feasibility study on bamboo (*G. angustifolia*) and plastic pipe in Colombia (1974).

Hen house: appropriate cages.

"A bamboo poultry house with thatch roof and slat walls provides good insulation. The elevated slat floor keeps chickens clean and healthy while the egg catch and feed troughs simplify maintenance. Costing mainly labor to build, housing healthier hens, such coops are used successfully in the Philip-



Bamboo animal cages and feeding troughs reduce expensive importation of metal cages, are more amiable to the caged, and can be repaired from locally available material. Their construction lies well within the tool supply,

economic means, and skills of any villager. These same qualities make them a good school project for early architects. Light cages are easily elevated on poles or hung from trees. Multiple stories economize space.

piners and Liberia. The house is built on a frame of small poles, with floor poles raised about 1 m [3 feet] from the ground. The floor poles are covered with large bamboo stalks, split into strips 38 mm [1½ inches] wide, spaced 38 mm apart. Floors so constructed have several advantages: better ventilation, no problem of wet mouldy litter during rainy season or dry dusty litter during dry season; droppings fall between split bamboo to ground, away from chickens. This eliminates parasites and diseases normally passed from hen to hen through droppings remaining warm and moist in litter. Wide spacing of floor and wall slats might invite marauders such as weasels and snakes. Tin shields on the support poles will keep rats and other pests from climbing.

"Walls are made from vertical strips of bamboo 38 mm [1½ inches] wide spaced 6 cm to 8 cm [2½–3 inches] apart. This also allows ample ventilation, needed to furnish oxygen to the chickens and to allow evaporation of excess moisture produced in the droppings. In the tropics, the problem is to keep chickens cool, not warm. Using a closed or tight-walled poultry house with a solid floor would keep them too warm and result in lowered production and increased respiratory problems. Shade over and around these houses is very important. If the ground around the houses is not shaded, heat will bounce into them.

"In Liberia, thatch roofing keeps the birds cool, is cheap and readily available to the small farmer or rural family, and so is most likely to be used. The roof must have an overhang of 1 m [3 feet] on all sides to prevent rain from blowing inside the house. It may be desirable to slope the overhang toward the ground.

"Feeders and waterers are made from 10-to-12.5-cm-diameter bamboo [4–5 inches] of the desired length, with a node or joint left intact in each end of the bamboo section to keep the feed or water in. A section 7.5 cm to 10 cm [3–4 inches] wide around half the circumference of the bamboo, except for 7.5-cm sections [3 inches] on the ends, is removed to make a trough. All nodes between the ends are removed. These feeders must be fastened at the base to keep them from rolling. The feeders are fastened to the outside of the walls about 15 cm [6 inches] above floor level. The hens place their heads through the bamboo strips to feed or drink, thus conserving floor space for additional chickens.

"Nests: The demonstration nests are 38 cm [15 inches] long, 30 cm [12 inches] wide and 35.5

cm [14 inches] high. The strips used on the floor of the nest are about 13 mm [½ inch] wide, spaced 13 mm apart, and must be very smooth. The floor slopes 13 mm from front to back, so that when the eggs are laid they will roll to the back of the nest. An opening 5 cm [2 inches] high at the back of the nest allows the eggs to roll out into an egg catch, resulting in cleaner and fewer broken eggs of better quality because they begin to cool as soon as they roll out of the nest. The eggs are also out of reach of egg-eating hens and can be conveniently gathered from outside. Placing the nests 1 m [3 feet] above the floor conserves floor space and permits more laying hens to be placed in the laying house. One nest is put in for every five hens.

"Split bamboo nests give unobstructed ventilation. Conventional lumber nests are hotter; this may cause hens to lay eggs on the floor instead of in the nests. This means more dirty eggs, more broken eggs, and more likelihood of the hens eating the broken eggs. The only way to cure a hen of eating eggs once the habit is formed is to kill her. Without an 'egg roll' in the nest, the hens sit on eggs laid previously, keeping them warm. The quality of eggs deteriorates very fast under these conditions."³⁵

Bamboo and chickens go well together. Groves provide shade, roosts, protection from predators and chilling winds, a food supplement recommended for chicks (prepared from chopped leaves rich in vitamin A), and a leaf fall that shelters lots of edible insects. The chickens return these favors with excellent fertilizer for the groves.

Bamboo camp.

BOY SCOUT BAMBOO. Backpacks, fishing poles, frames to stretch a tarp on—camp sometime by a bamboo grove, and you'll find that the instant handiness of the living plant has a true chance to emerge, given an abundance to play with. Such a bamboo camp for people to visit, to cut from and maintain, and to experience the full moon through the culms, take tea by a fire on one side with a flute on the other—such groves should be available near any big city in climates mild enough for bamboo cultivation. We playfully address ourselves to Scouts because they—girls and boys together—are the main massive group of young townspeople trying to maintain some touch with the untown, the terra firma beyond cement.

But a bamboo camp is a serious, low-cost, high-consciousness design for schools, churches, and other collectivities to consider for young and old. Inexpensive ways to exit from town must be

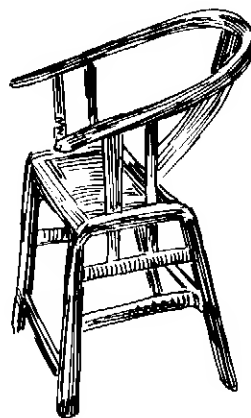


Appropriate travel for urban children is a high priority of contemporary cultural design. The bamboo camp is a cost-feasible norm.

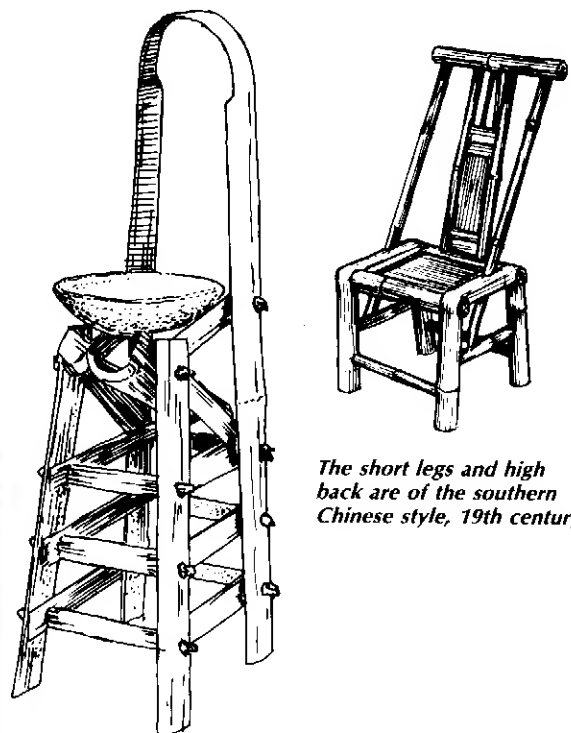
designed for the town's poorer people, especially families. Since shelter and food are two main travel costs, we should design this as a small hostel-garden where guests are also hosts, responsible for building and planting and all the work of being alive directly on the earth. The youth hostel system of Europe is a crude analogy, but a popular bamboo camp would be participatory and, in fact, a school in rural survival. The high cost of deprivation in such organizations as Outward Bound (which specialize in wilderness experiences for children of well-to-do urban parents who value bare feet) can't process sufficient numbers of city children to make a real impact on cultural consciousness in town. We provide below a sampling of possible projects for camp, school, or home.

FURNITURE. *The Philippine Craftsman* ran a series of articles from 1912–1914 on furniture and basketry native to the islands, intended to introduce profitable industrial arts work into the school system and directly improve the comfort and convenience of the Philippine home. The 7 articles comprise a guide with 154 pages of text and 133 illustrations showing 195 different basket styles and

sizes with 43 exercises for making them. The furniture section includes 64 photos and designs of chairs, desks, settees, couches, rockers, clothes hangers, foot stools, tables, hat racks, washstands, armchairs, beds, screens, and wardrobes, together with joint designs used in their construction and simple machinery used in the process. The group of articles is somewhat stiff and dated, but it represents the most extensive consideration in print of



The Chairman's chair. Mao's chair, of the 19th century or earlier, is standing in the cave museum of Yen-an. The splay legs are high, typical of the northern style in China.



Oil lamp stand, 19th century, Kuang-tung. A long piece of bamboo, shaved thin at the middle, is bent for the handle, and holes are drilled for joining the legs. The design can be expanded for a stool, high chair, or ladder.

The short legs and high back are of the southern Chinese style, 19th century.

The hidden curriculum of the bleak cube.

Blocks are such a staple toy in industrialized countries that it's surprising to learn they're only about a century and a half old. "The bleak cube as plaything was devised by a mild-mannered, humorless, early nineteenth century German schoolteacher, Friedrich Fröbel, the originator of kindergarten." Before becoming a schoolmaster, Fröbel had been a forester, architectural apprentice, museum curator, and soldier in the Prussian army. "Wartime duty taught him the merits of discipline, yet it was probably his bout with architecture that led to his infatuation with the cube.

"Fröbel's choice of blocks was prophetic. At the time he received his call to mold the minds of the little ones, the better part of the world was still tidy and fragrant, abounding in

forests and clear streams, with the sea's plangent waves unsullied by oily squish. However, in the course of time it was to undergo a fateful change that led to a new attitude toward life. It saw the destruction of the woods and the darkening of the waters, the growth of gigantic factories and block after block of equally gigantic housing projects. The infant had a preview of things to come right in the nursery, for hard-edge building blocks were his first encounter with the hard-bitten reality of life. At home and in schools on shelves within easy reach, the cubes are stacked in rows, allegedly for the child's amusement, actually for imprinting on his mind the principle icon of our architectural creed."

(Rudofsky 1977:355-6)

The circle and the square.

"You have noticed that everything an Indian does is in a circle, and that is because the Power of the World always works in circles, and everything tries to be round. In the old days when we were a strong and happy people, all our power came to us from the sacred hoop of the nation, and so long as the hoop was unbroken, the people flourished. The flowering tree was the living center of the hoop, and the circle of the four quarters nourished it . . . Everything the Power of the World does is done in a circle. The sky is round, and I have heard that the earth is round like a ball, and so are all the stars. The wind, in its greatest power, whirls. Birds make their nests in circles, for theirs is the same religion as ours. The sun comes forth and goes down again in a circle. The moon does the same, and both are round. Even the seasons

form a great circle in their changing, and always come back again to where they were. The life of a man is a circle from childhood to childhood, and so it is in everything where power moves. Our teepees were round like the nests of birds, and always set in a circle, the nation's hoop, a nest of many nests, where the Great Spirit meant for us to hatch our children.

But the Wasichus (the whitemen) have put us in these square boxes. Our power is gone and we are dying . . . You can look at our boys and see how it is with us. When we were living by the power of the circle, in the way we should, boys were men at twelve or thirteen. Now it takes much longer to mature . . . It is a bad way to live. There can be no power in a square."

—Black Elk (Neihardt 1961:198-200)

Bamboo Puppetry

No camp is complete without a fire. No fireside is complete without a tale. No tale is told more fully than by puppets, an ancient and supremely popular method of storytelling around the world.

Puppetry should be regarded as an art as valid as any other, and much more demanding than most, because it combines so many arts in its fully successful embodiments. Traveling with a traditional family of puppeteers should be included in the schooling of any serious student of the art.

Living on the road with puppeteers, the

student sleeps on stage below the limp figures that only a few hours before entertained an entire village. The priest, the young lovers, the one-eyed thief, and all the rest are motionless now, but their shadows quiver in the frail light of a kerosene lamp, and the student lies there remembering the stories and the dance of *the dolls who come alive* . . .

Bamboo can furnish tent poles, scenery, houses, and armature for puppets up to giant dimensions.

The Bamboo Cutter and the Shining Maiden

Bamboo legends abound wherever the plant is plentiful. Bamboo wombs are an element in many stories and often, as in this thousand-year-old tale from Japan, the moon is somehow intimately related to the plant. The tale is told at greater length, with 18th century Japanese illustrations of sumptuous elegance, by Fisher (1980).

A poor and childless bamboo cutter was pursuing his solitary trade as usual when early one evening, by the soft light of the rising moon he noticed a stalk of bamboo glowing at the base as though lit by a candle inside. Carefully cutting the internode open, he found a tiny girl, some three inches tall and beautiful beyond belief. He carried her home cupped in his hand like a baby bird, and built a tiny basket for her to sleep in, which she quickly outgrew. In fact, she grew as quickly as bamboo itself, and within three months she was a young woman of normal size, but of a beauty not only far beyond all local norm but almost, it seemed, beyond mortality. If anything, her beauty had increased with growth. Something in her flesh still glowed with the faint, unearthly light the bamboo cutter had first noticed in the grove. Rumor of her rippled to the four corners of the kingdom. Her downcast eyes were the torment forever after of all who caught a furtive glance of them. Her dark lashes lay at the restless center of a thousand dreams. Suitors flocked to her gate like bees swarming to the world's last rose, but the shining maiden would have nothing to do with them. As months dragged on into years, her reputation ripened to terrible but established fact, and all except five persistent idiots finally went home.

This small group remained loyal with a tenacity that was either bestial or divine; human behavior offers no parallel. In summer, their jackets stuck to their sweaty flesh; in winter, snow muffled their lutes. Every evening they presented a fresh sonnet or performance of some sort, sometimes even a small skit in which all took parts. Long residence before the same frustration had reduced them to unity; they had grown brothers rather than rivals, five fingers of a single courting hand. If any had been accepted at this point, the four others would have chipped in for the ring, both for the sake of a familiar friend and to be relieved at last of an ordeal that had already claimed too much of them to be abandoned, but which was devouring the rest of their sanity and fortune at a pace too rapid to last for long.

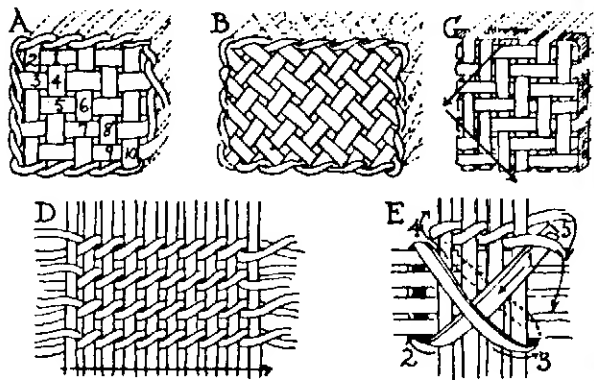
At last the poor bamboo cutter decided to discuss the matter, and suggested to the shining maiden that she marry one of these poor men.

At last she agreed—provided each run an assigned errand first. The old bamboo cutter hurried out to tell the suitors, who were just finishing their evening serenade. One was playing mournful music on a bamboo flute while a second sang a song declaring he could live without food if he could kiss, daily, a spot freshly shadowed by her hand, while the others whistled and beat time with their fans. "Listen," he called to them from the balcony, interrupting the performance, "the shining maiden has agreed to marry whoever returns from a quest with what she wants." They were overwhelmed; and when the shining maiden herself came out, they were even more overwhelmed to actually see her after all these completely unencouraging years. They were most overwhelmed when she told them what they had to get. One had to fetch the Buddha's begging bowl; another, a jewelled branch from the golden tree with silver roots growing on Paradise Mountain in the Eastern Sea; another, a nonflammable robe sewn from a hundred hides of a certain magical species of Chinese rat with habitat of fire; another, a jewel with five colors from a dragon's head; the last, a special charm for easy childbirth, plucked from the womb of a nesting swallow.

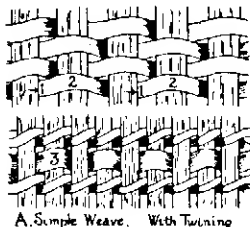
The suitors were completely flabbergasted. They felt hopeless, angry, and tricked. "Why don't you just say, 'Go home and stay home.' None of these things can be bought in Japan!" The shining maiden just turned aside to gaze at some bamboo growing by the cutter's gate. "I don't see what's so difficult in any of this," she said quietly.

Some of the suitors tried to trick the shining maiden, faking the begging bowl, hiring teams of jewellers to fabricate a jewelled branch . . . all failed and either went home filled with shame or embarrassment, prudently abandoned the search in mid-quest and never returned to the maiden, or died. All of this naturally found its way to the ear of the Emperor and made the shining maiden appear a fitting conquest for the Imperial Charm. But the elaborate stratagems of the Emperor met with little more success than the rest, and when, in time, the moon-men came to take the shining maiden home again, 2000 Imperial troops sent to prevent them became rag dolls, sprawled helpless before the radiance of these creatures from another plane.

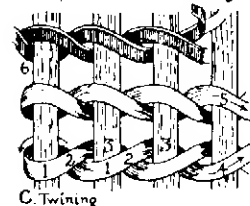
The shining maiden left a last fond letter to the Emperor before departure and he went to burn it on the tallest mountain, where it smoulders still, so people call it Fuji, the Never Dead.



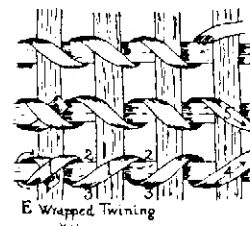
Square-bottom bamboo baskets: basic base weaves. Plaited base with checked weave (A); diagonal checks (B); twilled stitches (C); twined base (D); cross-tie center (E).



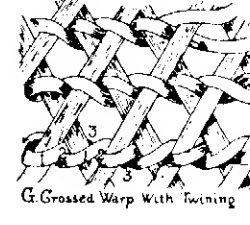
A. Simple Weave. With Twining



C. Twining

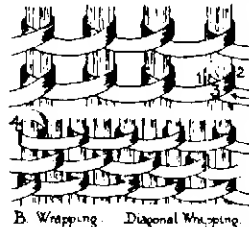


E. Wrapped Twining

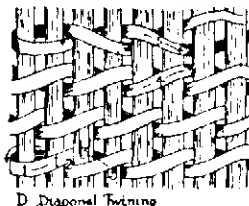


G. Crossed Warp With Twining

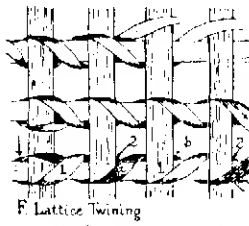
Weaving stitches for bamboo and other flat materials. (A) Simple weave (above), with twining (below). (B) Wrapping (above), diagonal wrapping (below). (C) Twining. (D)



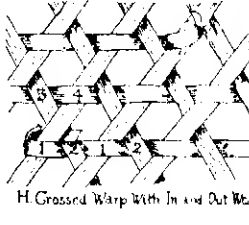
B. Wrapping. Diagonal Wrapping



D. Diagonal Twining

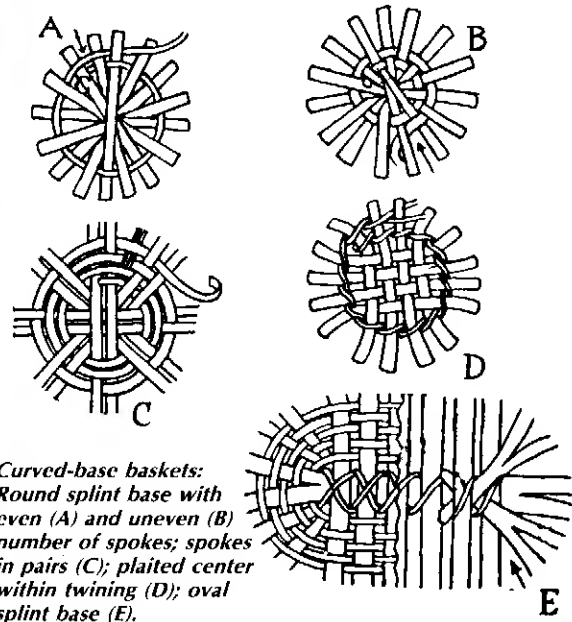


F. Lattice Twining



H. Crossed Warp With In and Out Weave

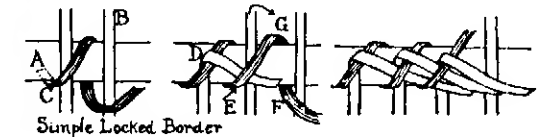
Diagonal twining. (E) Wrapped twining. (F) Lattice twining. (G) Crossed warp with twining. (H) Crossed warp with in-and-out weave.



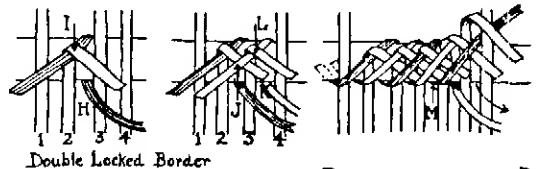
Curved-base baskets: Round splint base with even (A) and uneven (B) number of spokes; spokes in pairs (C); plaited center within twining (D); oval splint base (E).

Basket borders for bamboo or other flat materials. (A-G) Simple locked border. (H-M) Double locked border. (N-O) Border with twined edge. (P-Q) Simple

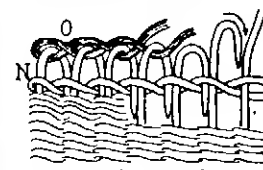
wrapped border. (R-T) False braid border. (U,V) Twined border over groups. (W,X) Interlaced border. (Y,Z) Openwork braid border.



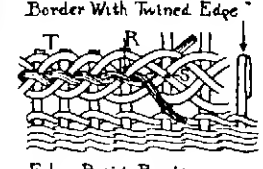
Simple Locked Border



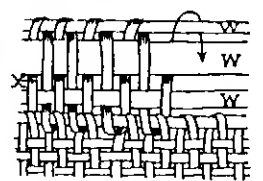
Double Locked Border



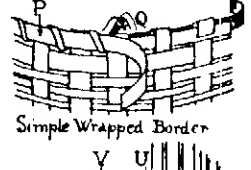
Border With Twined Edge



Simple Wrapped Border



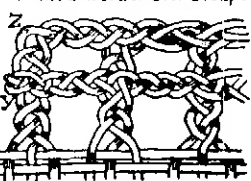
False Braid Border



Twined Border Over Groups



Interlaced Border



Openwork Braid Border



Basket birdhouse of bamboo with cornhusk thatch. Bamboo's rapid foliage can attract birds to cities in greater numbers and provide them with nest-building twigs, leaves, and sheath fragments.

practical works with bamboo in education. A condensed version should be made widely available, supplemented by other world bamboo designs for toys, furniture, musical instruments, playground equipment, kites—the whole range of small projects possible with bamboo, graphically and suggestfully presented.

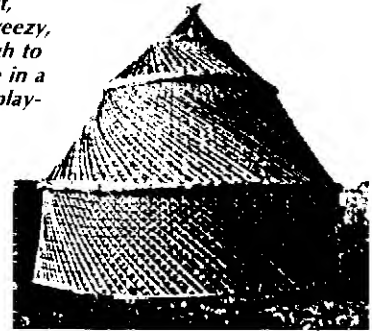


*Dramatic architecture. Bamboo's light weight, strength, and floatability have inspired shelter solutions distant from our present norms and provide inspiration for exciting structures. Tree shelters, water sites, and rolling road homes are amply and philosophically considered by Rudofsky's *Prodigious Builders*, from which the following illustrations and most of these thoughts*

derive.

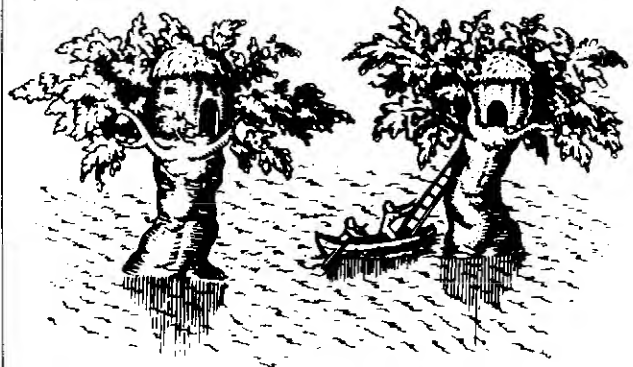
Nest dwellings with bird's-eye views and basket elevators are an architectural option explored in the South Pacific. The basket elevator occurs often in legend and history. Saint Paul escaped from jail in one, and at Mount Athos, the Greek monastery, entering monks were supposedly lifted in them to the dizzying heights of the famous retreat.

Moroccan picnic hut, open, bright, and breezy, is lightweight enough to be hung from a tree in a smaller version for playground or camp.

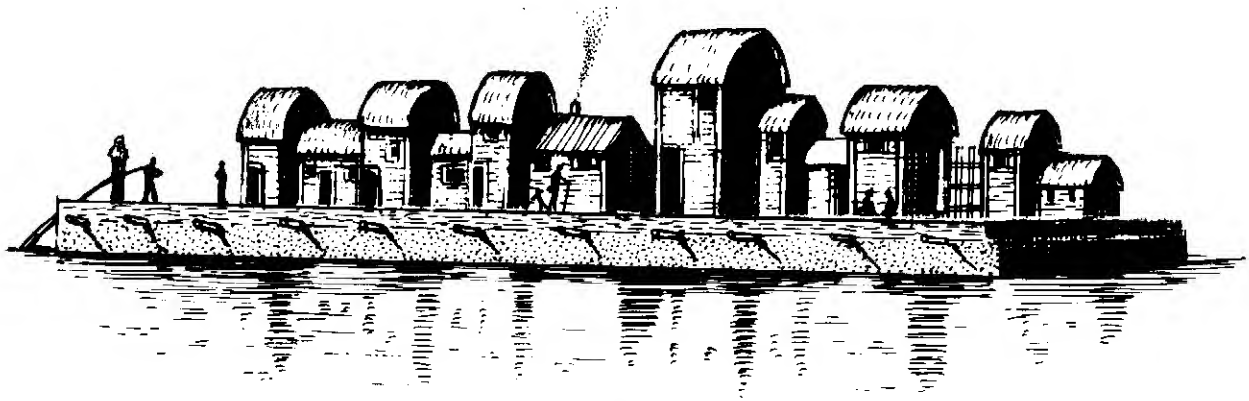


BAMBOO TIPI. A bamboo tipi is easy to make and unmake. Laubin, in *The Indian Tipi*, notes how children among the Sioux imitated the shelters of their tribe: "Little girls had small tipis made under their mother's direction, in which they played house. They even made little tipis for their favorite dogs. Children also made tiny tipis and villages from the larger leaves of the cottonwood, pinning them together with splinters or thorns. Following the Custer battle, the paper money found on the soldiers was turned over to the youngsters, who made play tipis of it. A small tipi for children in the corner of the yard needs only nine poles in the frame, 11 to 12 feet long, and two for the smoke flaps . . ."

Tipis and other tribal shelter forms suggest themselves as an excellent introduction for children to building principles. A few forms are given here, but many more can be easily found in *Shelter* (1973) and other publications on buildings by the people.



Tree houses require less land for foundations than any other form of domestic architecture, an interesting feature in a crowded world. In the Orinoco River (Venezuela), air and water provide sites for woven and thatched tree-top nests.



Bamboo island villages of up to 200 families on the Yellow River astonished 17th century European travelers in China. "The best artists in Europe would but coldly be able to make the like of the same stuff, a common reed which the Portuguese call bamboo, on which they set up their huts with wives and children. They keep and feed aboard their is-

land all manner of tame cattle especially hogs . . ." Another traveler reported flowers, vegetable gardens, and orange trees as well. (Rudofsky 1974:146.) Any-one who has ever lived on a houseboat knows the lure of a floating home, which should be indulged wherever children, water, and bamboo of sufficient dimensions occur together.

PAPER

The place of paper.

*Rags make paper
paper makes money
money makes banks
banks make loans
loans make beggars
beggars make rags.*

—Anonymous English Verse

Many centuries before rags dropped off the legs of beggars for the task, bamboo was busy making paper in the East. That role is being examined with increasing interest by the Food and Agriculture Organization (U.N.) and other planet planners in the context of a dramatic rise in demand for paper around the globe. World paper use increases 5 percent annually, roughly twice the population growth. In some countries, it rises as much as 30 percent annually. About 85 percent of the world's paper comes from six countries, and most of it goes to the United States, Western Europe, Australia, and New Zealand, where per capita paper consumption shows a "spectacular discrepancy" (FAO) when compared with rates elsewhere in the world. Newsprint, which accounts for over a third of world paper use, is one example of this imbalance: Asia,

with over half the world's population, uses 3 percent of the world's newsprint.

The 75 cubic meters of wood now standing in the world per person will be reduced to half that by the year 2000 at current deforestation rates—an acre a minute in tropical forests, according to some estimates. "Though developing countries contain three fourths the world's peoples and more than half its forest, they account for just 13 percent of global consumption of industrial wood. The average American consumes annually about as much wood—1 cubic meter—in the form of paper as the average resident in many Third World countries burns as cooking fuel."³⁶

Paper plenty in densely industrialized societies forms an important part of their dominance over areas that are paper poor. Wealth depends in large measure on information storage and retrieval. The ease of information flow determines the school style and training capacity of a culture. In a number of ways, paper is the root of money and helps to broaden the gap between those with and those without. Developing countries trying to crawl from the deep pit of economic colonialism could profitably invest energy in being paper free, independent of imports. Many, like India, are in the hot and hungry middle of the world where bamboo happens most abundantly.

PAPER HISTORY.

Man's high state of civilization can be easily construed to be more directly dependent on the inventions of paper making and printing than to any other development: these permitted wide dissemination of knowledge in time and space.³⁷

Many surfaces have been used by many cultures as a message package. Papyrus (a plyreed mat from which our word *paper* comes) and woven

cloth were used in Egypt. Parchment—from the inner hides of sheep—dates from about 1500 B.C. in Asia Minor. Vellum, from the whole hides of goats, lambs, and calves, was also used, but vegetable fibers were a more common message base. In North America, birch bark was a natural choice; in Asia, palm leaves. Sometimes, as in Ceylon, these were strung together on a string for “leaves” of books. Hemp and mulberry were employed in the South Pacific and in the Aztec and Mayan cultures of the Americas. The latter boiled the inner bark of these plants in a solution of wood ash and mashed the resulting mush on a flat surface, forming scrolls and accordion-fold books, few of which survived the Spanish conquistadors zeal to sow a monoculture and monocreed. The art, however, survived its artifacts: The technique persists in southern Mexico among Aztec and Mayan descendants.

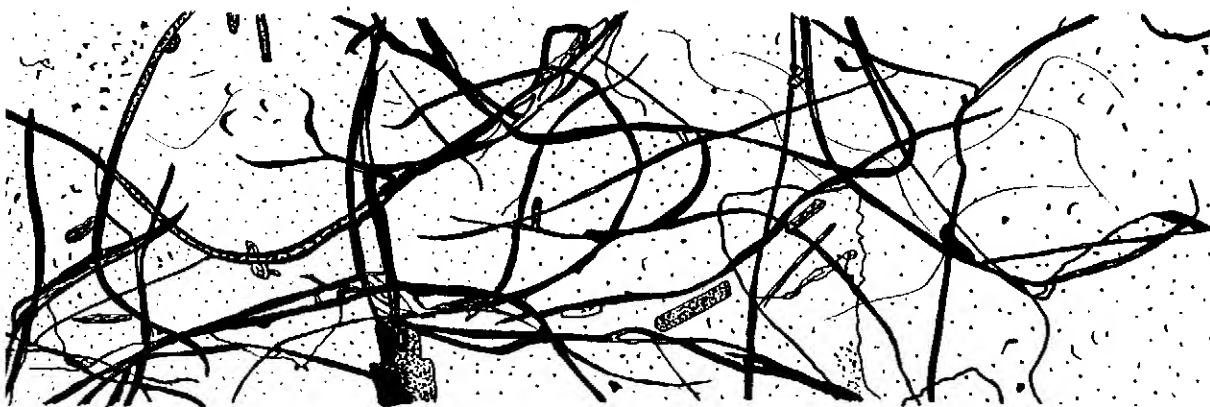
In China, records before paper were kept on thin strips of bamboo, which proved durable enough to survive over two thousand years in fresh and legible condition. Military grocery lists and funeral inventories have survived (by chance) longest, and the classic volumes of Chinese history and philosophy were also long preserved by this means: “The Great Learning is the core of Confucius, the gate of sanity. If we today can see how the people of old went about their study, it is due solely to the conservation of these strips of bamboo.”³⁸

China’s cultural longevity is in large part owing to its respect for the past, and part of the early affection for bamboo derived from its help in erecting an extensive cultural memory. The bamboo shavings were nearly a foot long, one character wide, punctured at one end, and tied together with

silk or leather. But the thin strips proved a fat storage device, with a low index of data per unit of space: a 300 B.C. emperor required a number of carts to carry the books needed on a journey. A light but strong paper can weigh less than one third of an ounce per square yard (10 grams per square meter). “Miniaturization,” increased performance per pound, a chief feature of all evolving technologies, is dramatically embodied in the invention of paper.

It is hard for us to reenter the wonder feeling excited by the world’s first paper for those who actually witnessed its arrival in the midst of the bulky obsolescence it replaced. Making your own paper for the first time is perhaps the most direct route to experiencing that historical moment when true paper joined the human race, around A.D. 105, fashioned through the cunning of a Chinese eunuch using boiled fishnets. The essential process of papermaking has remained unaltered for nearly two thousand years since its invention; though mechanization, begun some two hundred years ago in Europe, has vastly accelerated the procedure.

True paper, as distinguished from the vegetable and animal writing surfaces described above, is made by “cooking” rags, straw, bark, bamboo, wood, or other fiber materials until the fiber can be separated from its mortar in the living plant. This pulp floats in a weak consistency—about 1 percent—of water, its fibers completely separated from one another in a large vat. A screen is passed through the vat collecting a mat of fibers. As this screen is removed from the water, the surface tension of the water draws together neighboring fibers, and tiny fibrils on their surface lock them together,



*A world paper shortage is inspiring a closer look at bamboo. This is pulp of *Guadua angustifolia*, $\times 75$.*



European papermaker, 1558. Arabs founded the first paper mill in Europe, at Xativa in Spain, A.D. 1150. Monks—the only scribes in the society—initially opposed paper because it came from the Arabs and was thought less permanent than vellum (calfskin) or

parchment (sheepskin). Handmade paper in the West has become a craft of the few, but mechanization needn't eliminate knowledge and appreciation of the homemade process. Gandhi encouraged village papermaking for rural self-sufficiency in India.

producing a uniform sheet some four to five times as thick as the final, dried piece of paper.

This art took a thousand years to diffuse to Europe, traveling fewer miles per year than a person could walk in a few hours. It was introduced by the Moors to Spain around A.D. 1150 and spread quickly north within the next century. Combining paper technology with movable type in the first printing of the Bible (A.D. 1440) opened up the "Gutenberg Galaxy" of Western cultural evolution, some thirteen hundred years after the Chinese had first made paper and four hundred after the Chinese invented type (A.D. 1041).

An important early technical advance in the industry was the invention of the screen or sieve on which the wet fibers of pulp were lifted from the vat. Thin strips of bamboo—as many as twenty to forty to the inch—provided a surface from which the wet sheets could be "couched" or removed

rapidly, permitting quick reuse of the screen. Metal replaced bamboo as the screen material in the West. It releases paper very wet and permits a finer weave, producing a smoother surface, with about fifty-two strands per inch. In modern screens, metal has been replaced by polyester plastic.

First in France, then in England, as the eighteenth century moved to the nineteenth, machines began to be invented with an endless loop of metal screen. The basic method of making paper was not changed but mechanized, with innumerable refinements continuing to the present mammoth paper-making monsters pouring out bands of paper 30 feet wide at roughly 30 miles per hour, to be wound on immense rolls 4 feet in diameter. One machine can produce 600,000 pounds of paper in one 24-hour period, roughly equivalent to ten years' production—at around 200 pounds per day—for one vat man working by hand.³⁹

HANDMADE IN CHINA. For nearly 2000 years, bamboo paper has been handmade in the East. For seventeen of the nineteen centuries since its birth, all paper was made *only* by hand. All the variants of the process as practiced in a number of oriental countries with bamboo cannot be examined here, but two brief accounts of some phases of the trade as hand done in China, paper's native land, will suggest the main method. They come from observations by Westerners written in the early decades of this dwindling century.

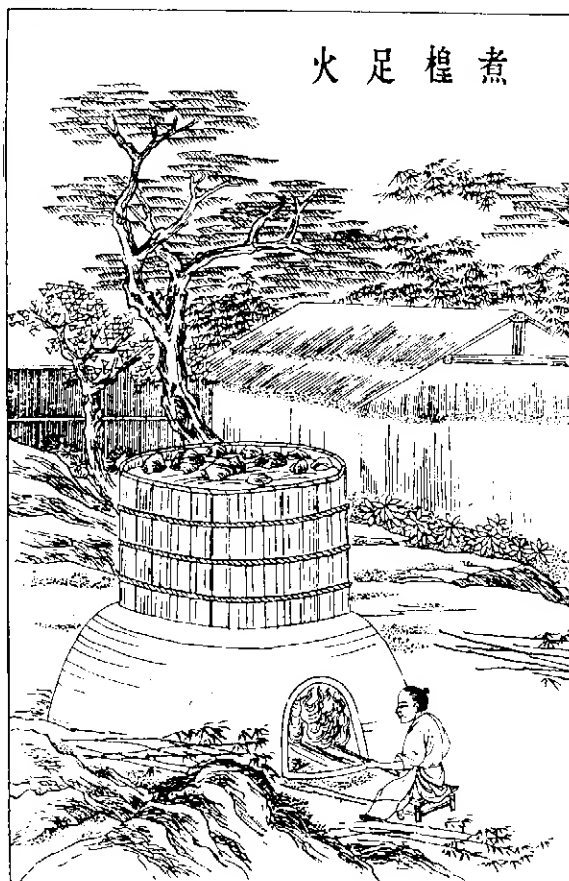
"The stems are cut into lengths, made into bundles, and immersed in concrete pits, being weighted down under water by heavy stones. After three months they are removed, opened up, and thoroughly washed. Next they are restacked in layers, each layer being well sprinkled with lime and water, holding potash salts in solution. After two months, they are well rotted. The fibrous mass is then washed to remove the lime, steamed for fifteen days, removed, thoroughly washed, and again placed in concrete tanks. The mass is next reduced to a fine pulp with wooden rakes and is then ready for conversion into paper. A quantity of the pulp is put into troughs with cold water, and mucilage prepared from the roots of *Hibiscus abelmoschus*. An oblong bamboo frame, the size of the desired sheet of paper, having a fine mesh, is held at the two ends by a workman and drawn down endways and diagonally into the liquid contents, which are kept constantly stirred in the trough. It is then gently raised to the surface, and the film which has collected on the top is deposited as a sheet of

斬竹漂塘

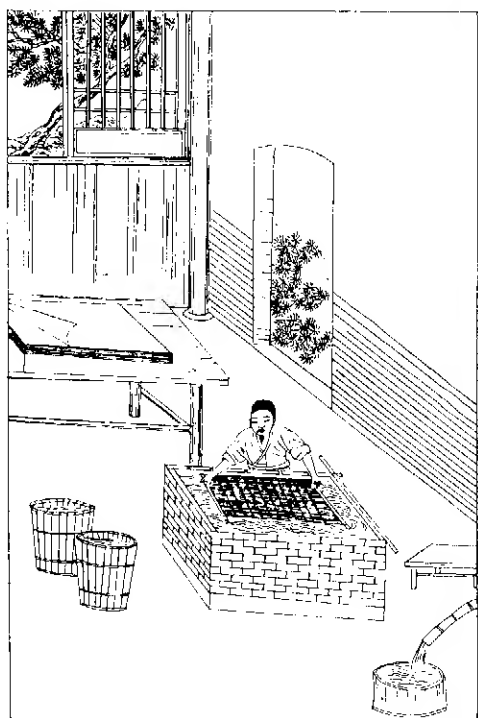


A

煮棹足火

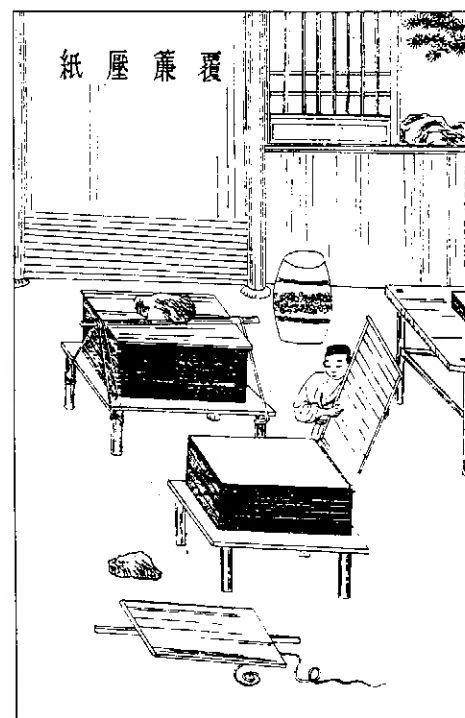


B



C

覆簾壓紙



D

Paper production by hand in China: illustrations from the T'ien Kung K'ai Wu, a work of the Ming dynasty (A.D. 1368-1644) dealing with the arts and industries of ancient China: (A) Preparing culms for retting in a vat with lime to free the

fibers from the starchy parenchyma tissue that mortars them in place. (B) Cooking the pulp. (C) Vat-man forming sheets with a bamboo screen, with tubs of sizing to the left of the vat. (D) Pressing the finished sheets.

moist paper when the frame is turned over. After the surplus water has drained from the mass of moist sheets of paper, the whole is submitted to pressure. It is then dried; the cheaper papers in sunlight, the superior quality in kilns. Much water is necessary in papermaking, so mills are always erected alongside streams."⁴⁰

"A paper mill depends on sufficient pulp in easy reach, a steady clear water supply, and cheap digesting materials, such as quick lime, soda ash, or potash. Primitive methods employed in old mills where paper is handmade are inadequate for refining the highly lignified tissues of mature bamboo culms. Better grades of paper are therefore made only from young and still leafless culms. Requirements are less exacting for cheap papers, and a wider range of species is employed. Probably any abundant local species, reasonably priced, may be used. Mature stems are acceptable for the very coarse dark papers of common use for filters, wrapping, and so forth—for which mature culm tips, a by-product of the split-bamboo industry, are used in Southeast Asia. Digestion time is very long, often a full year. Pulping methods are not highly refined.

"In construction of the common mold, on which the finest paper is still made by hand in the Orient, bamboo is always used: a flexible screen of slender wirelike units fastened together in parallel order with hair, silk, or ramie. Peripheral wood of large moso or madake culms make the best screens. After preliminary splitting, strips are reduced to size and cylindrical form by pulling through holes in a piece of steel, which produces wirelike strips of marvelous uniformity and fineness. Finished screens, treated with lacquer, are objects of great beauty and unbelievable durability. The binding fibers, the 'warp,' wear out before the strips. When these can no longer be repaired, the bamboo strips are salvaged and worked into a new screen.

"Bamboo finds numerous incidental uses in the average Oriental handmade papermill. Half-stuff is carried from the digesting vat to bamboo treading troughs in bamboo baskets suspended from a bamboo pole. Finished pulp is 'combed'

with bamboo loops to remove coarse fibers—'shives'—which have escaped reduction by digesting and treading. In the dipping vat, water is added and pulp agitated with bamboo stirring rods to disperse fibers evenly. Vat man and drier work by bamboo lamplight at night. Bamboo rope is used on the windlass for applying force to the press. Bamboo forceps are used to pick up the corners of the wet sheets from the block as it comes from the press. Old bamboo culms too highly lignified for handmade pulp are commonly used as fuel for drying the paper. Bales of finished paper are often covered with bamboo culm sheaths and bound with bamboo bands. A bamboo tool, combining the functions of a gauge and an awl, is used to space the bands on the bales and tuck in the twisted ends.

"The principal technical problems blocking bamboo use for pulp in modern mills have been solved. Many variants of the process have been patented in those countries where paper is made on a large scale. At least one of the several modern papermills established in pre-Communist China used bamboo pulp, making ninety types and grades of paper, ranging from wrapping paper and tissues to bond and ledger."⁴¹

MODERN METHODS. It is not China but India that has taken the lead in the Orient and the world in the production of bamboo paper. With some 20 genera, 113 species of bamboo covering almost 3 percent of her land—an estimated 9.57 million hectares or nearly 24 million acres—India is blessed with the largest bamboo reserves of any country in the world. Of roughly 3.23 million tons of air-dry bamboo—20 percent of India's total annual wood production—about 2 million tons is consumed by the paper and rayon industries.⁴²

The extent of bamboo reserves in the country has had an interesting influence on bamboo research. In spite of the fact that the United States has only two native species and England none, English is a primary language for bamboo research. In the mid 1800s, England's empire—far-flung, literate, and addicted to print, connected and ruled by messages on paper—needed a backyard bigger than Sherwood Forest to grow paper pulp. Queen Victoria declared herself Empress of India in 1877 and became legal owner of vast resources of bamboo, which Englishmen like Routledge (1875) and Raitt commented on with sufficient persuasion to inspire the opening of bamboo paper work in India in 1910, soon making India the world's largest user of bamboo.⁴³ The stream of publications in *The In-*

dian Forester on bamboo since 1875 and the research center at Dehra Dun—north of New Delhi—have helped make English the main Western language for bamboo studies.

As surely as the foot of the ox is followed by the cart's wheel, increased bamboo study has been followed by increased bamboo use. The 6,000 tons of bamboo used for pulp in India in 1925, by 1953 had increased to 80,000; by 1959 to 450,000; by 1970, to 800,000; by 1980, to 2.2 million tons. Projections are for 3.1 million tons to be used by 1985, and 3.5 million, by the year 2000.⁴⁴

Meanwhile, other countries have followed India's lead. Pakistan, Burma, Indonesia, Taiwan, China, the Philippines, Kenya, and Brazil—among other nations—now use bamboo paper pulp on a large scale. Increased need is a principal reason for increased interest in bamboo. As modern packaging and literacy grow worldwide, so also does the consumption of paper. In Thailand during the 1960s, for example, paper needs tripled, but 75 percent of the paper was imported. Properly managed, large bamboo forests in northern Thailand that presently provide only 15 percent of Thailand's paper could supply all of the country's domestic need and leave excess for export as well.

WOOD AND BAMBOO PULP. Use of bamboo for paper pulp on an industrial scale is only sixty to seventy years old, but papermaking already accounts for a significant proportion of the world's bamboo consumption. Improved grove maintenance, the world paper shortage, and diffusion of techniques and machinery are expected to increase dramatically the quantity of bamboo pulp production in the years ahead; but the principal reason for that increase will be the natural advantages bamboo possesses over wood as a raw material for papermaking.

Trees such as pine must be individually planted, require fifteen to thirty years to mature, and yield only one cutting. Reforestation is necessary after each harvest. Bamboo, on the other hand, spreads unaided after planting, and a single rhizome and its descendants yield hundreds of culms in the total life of a grove. In China, twenty-four bamboo stems of moso (*P. pubescens*) were planted, tended, and left unharvested. In twelve years they increased to 3,200 stems.⁴⁵ Bamboo matures in three to six years, but one-to-four-year-old culms are preferred for pulp, and the grove flourishes through regular thinning in cutting cycles of one to four years. It should be stressed how much harvest-

ing increases the vitality of a grove. In one experiment lasting eight years, reduction of the number of culms by 40 percent actually increased the total harvest weight over one third.

In the thirty years one pine harvest is maturing, an established grove of bamboo may be harvested ten to twenty times, depending on the species and other factors determining the cutting cycle. "Bamboo has no bark to be removed and its high specific gravity (± 0.6) makes possible 10 to 20 percent increase in the effective pulp capacity of the digester. It is estimated that six or seven times as much cellulosic material can be obtained per hectare from a bamboo forest as compared to a coniferous or other broad-leaved forest. Bamboo fibers are longer than those of hardwoods but are shorter than those of most coniferous woods. Length to width ratios are higher than those of wood fibers; the bamboo fibers are strong and flexible rather than stiff and brittle—features that are better for most papers, especially high-quality ones like facial tissues, bond papers, and stationery."⁴⁶

One constant of the history of paper manufacture has been a chronic shortage of raw resource. Around 1850, when cotton and linen rags fell drastically short of paper demands, cereal straws and then esparto grass supplied sufficient pulp for some twenty years. Around 1870, acute shortage was relieved with new chemical processes to convert coniferous woods into cellulose. But increased use increased demand for paper. A half century after conifer pulp rescued the papermaker, the world was consuming 20 million tons of paper products annually, and cellulose industries of many sorts were evolving to further devour the forests. At Dehra Dun, the Forest Research Institute was concluding, with increasing experience to firm their feeling, that bamboo was the only feasible alternative available in sufficient quantities to meet the global demand for paper.

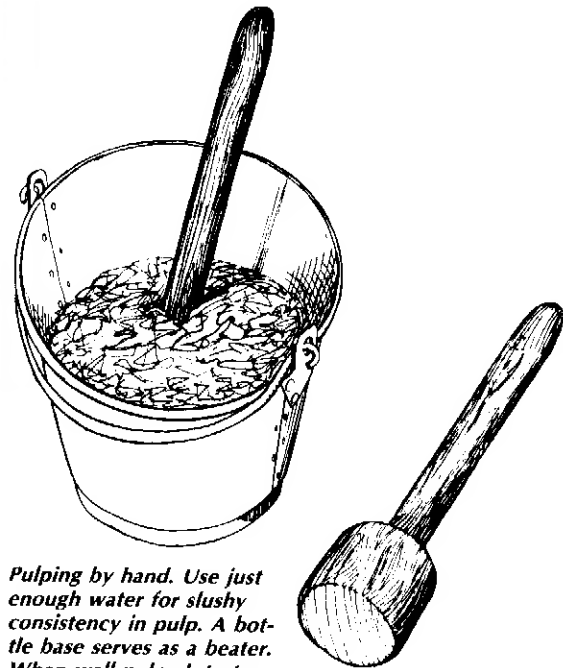
Drawbacks in bamboo paper production include the large amount of rootstock necessary for propagation, the adaptations in pulping machinery necessary for processing bamboo, the periodic flowering and death of groves, and the high cost of shipping. The solutions presently researched, proposed, or enacted include tissue culture of bamboo to start thousands of plants from the tip of one shoot, reliance on a number of species so that flowering cycles do not coincide, and processing at the groves as far as the pulp stage to save on transport.

Bamboo pulp can also be a by-product of other industries. In Taiwan, annual waste from

bamboo-shoot canning plants of 35,000 metric tons of culm sheaths has inspired an effort at creative garbage disposal. The Taiwan Forestry Research Institute began experimental runs for printing paper and the corrugated guts of kraft paper board with satisfactory results: The product was comparable in quality to the printing paper made from 80 percent rice straw and 20 percent long wood fiber. Paper yield was about 30 percent, comparable to rice straw. Strength and brightness of the culm sheath papers were rated better than rice straw papers. For the corrugated innards of kraft paper boards, yield was 45.8 percent, lower than *bagasse** (50–65 percent) and conifers (60–75 percent). The fiber dimension of bamboo sheath was inferior to bamboo culm and conifer fibers, but better than some hardwoods. Dehydration of the wet culm sheaths from the canning factories, in a simple and economical form, appears to be a critical problem.⁴⁷

PAPER MAKES SCHOOLS. The paper beneath the words you're reading may be the first you've seen in your life inviting you to think about paper. We haven't been taught to look at the paper, but at the words—which are curiously silent in our schools about the paper they're sitting on. Paper is the invisible foundation and environment of the educational method, but its manufacture and world distribution and the ways to make it from scrap paper or fibers of many locally available plants are not discussed or demonstrated. Simple methods of paper production could profitably be added to school curriculums in an effort to increase awareness of this material so central to the cultural evolution of any person or nation in our times. Making one's first sheets of paper is an astonishing experience for anyone who has dealt with paper for years without making it. It is an experience easily incorporated into the school system of any country—with or without bamboo. Lampshades, screens, curtains, paper partitions in houses after the manner of the Japanese, packages, kites—these are a few immediate uses for handmade papers. Here, briefly, is how: You don't have to wait for a bamboo harvest. Junk mail will do.

PAPERMAKING IN YOUR KITCHEN SINK. Save scrap paper. Cook a while until soupy. Squeeze a handful of pulp damp dry and put it in 3 cups of fresh water



Pulping by hand. Use just enough water for slushy consistency in pulp. A bottle base serves as a beater. When well pulped, test a little with twice as much water in a jar. There should be no recognizable particles of paper left.

in a blender. A fine screen on a wooden frame built the size of paper you want to make is fitted snugly into a wooden box with four sides but no bottom or top. Leave just enough room around the frame for your fingers. The box is then placed in the kitchen sink or tank of like size, which is filled with water to within a few inches of the top of box. The 3 cups of water with dissolved pulp is then poured into the water above the screen and gently agitated to distribute the fibers uniformly through the water.

Slowly lift the screen, and the fibers will become evenly distributed over its surface as it is raised from the sink. Turn the screen over on a paper towel or other absorbent surface, and soak up any excess moisture through the screen carefully with a sponge. Then lift the screen off the latest sheet of handmade paper in the world, and let it dry in the sun.

The texture and color can be infinitely varied by small additions of vegetable fiber such as grass clippings, greens of vegetables such as carrot tops, beets, leaves, corn silk, shredded corn husks, or onion greens. Dozens of alternatives await your experiments in your backyard, groceries, or nearest vacant lot. For a school project, Chinese handmade papermaking methods could be imitated on a small scale. Handmaking paper in schools will not solve the world's paper shortage. But it will make for a

*Editor's note: Bagasse: the fibrous residue of sugar beets or sugar cane after the juice has been extracted.

more paper-conscious populace, give some paper geniuses an early start with their obsession, and perhaps even inspire governments—especially in developing countries—to acknowledge the central seriousness of designing paper self-sufficiency as a precondition for many cultural processes. Ministries of education, particularly, should assign the national student body the homework of designing and creating national paper autonomy. Any countries poor in paper but rich in bamboo reserves or blessed with a climate friendly to bamboo cultivation will be knocking on the door at Dehra Dun to collect advice.⁴⁸

FOOD

Eat your lawn: bamboo shoots.

The best way to control bamboo is to eat it.
—David Fairchild

In Taiwan, a single factory turns out 150 tons of bamboo shoots daily;⁴⁹ roughly 8,000 tons a year are consumed there and roughly as much in Japan. This amounts to 22 tons each day and indicates how common a part of the oriental diet sprouts are.



"Those who savor the roots of wild vegetables know the meaning of life."—Wang Hsin-min (Sung dynasty)



Arundinaria bamboo shoots.

But in the West, except for those with their own grove, shoots are available only as a canned delicacy. In a few locations, such as Chinatown in San Francisco, shoots are sold out of great tubs of water. The price in 1980 was \$1 per pound.

When bamboo is cultivated for shoots, workers walk the fields barefoot, heaping soil around those spots where their toes feel a slight rise in the ground. The bulge heralds an emerging culm, which is kept covered as long as possible, sometimes with a wooden box, because when exposed it becomes fibrous in a short time. The shoot is harvested when about 1 foot tall, by digging down and carefully severing it at the point where it joins the rhizome bearing it. Shoots are boiled a half hour or more, and the outer sheaths removed. They are white in color, with the look of a raw potato, crisp in texture. In taste they are like young field corn, slightly sweet.

Fairchild's advice—to control bamboo's spread by eating it—has probably never occurred to most people who have a problem with excessive growth in a small urban garden, but shoots of almost any bamboo can be eaten. The principal genera used for sprouts include *Arundinaria*, *Bambusa*, *Dendrocalamus*, and *Phyllostachys*. Although size

is one limiting factor, even diminutive *Sasas* in Japan provide some 600 tons of shoots annually.⁵⁰

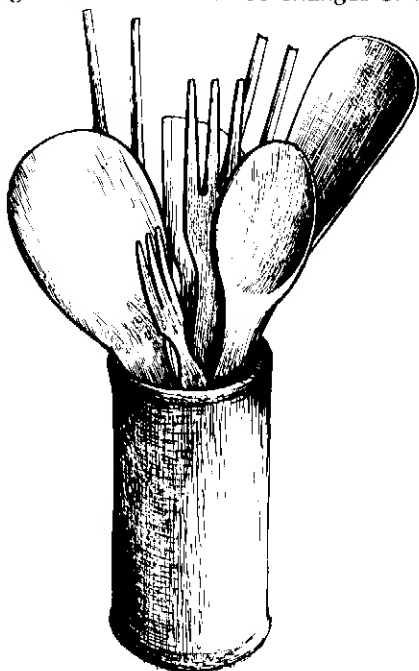
In Taiwan, per capita consumption is six times that of Japan, though total volume of shoots—8,000 tons annually—is about the same. *P. edulis* and *D. latiflorus* use has reached a high degree of specialization, including processing, canning, and export. Shoot export value in 1977 reached almost 25 million in U.S. dollars. Exported bamboo products the same year valued at \$40.8 million U.S. was double the \$20 million or so of 1973.

In Japan, *Phyllostachys* managed for shoots—mostly moso, *P. edulis* (or *pubescens*)—are topped off (pollarded) at 30–40 feet so that sunlight and warmth help prevent snow damage. Minimum temperature for shoot production is 20°C; shooting seasons are April–May and November. Yield of about 10 tons per hectare per year is valued at 1 million yen (yen = \$0.00455 U.S.) or \$4,550 U.S. per hectare. Costs invested are generally 10–30 percent harvest value. Soft, quality shoots require yearly soil dressing, straw litter, and farmyard manure.

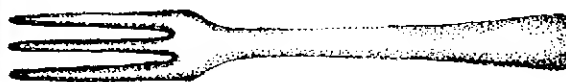
In Korea, shoots are collected April to mid May, nearly 9,000 lbs. per acre (10,000 kg per hectare) from an intensively managed grove. At 280 won each, shoots value about \$0.47 (won = U.S. \$0.001671). Taste research is conducted, and the most vigorous shoots are preserved as mother culms.⁵¹

COOKBOOKLET

The bitterness of some bamboo sprouts is removed by boiling in two or even three changes of water:



"A sprout properly dug will have a rooty, woody, basal portion, increasing sharply in diameter upward for a short distance from the very slender part which was attached to its rhizome, and then tapering to a point. With a sharp paring knife cut lengthwise through the sheath only, from tip to base of the sprout. Beginning with the lower sheaths, remove all except the tender ones at the tip. If there is a grayish layer (owing to age) next to the lower nodes, pare this off. Remove the tough basal part. Cut the core portion diagonally or crosswise into rather thin slices. The lower, firmer portion should be cut across the grain, not thicker than 1/8 inch, but the more tender middle and upper parts may be sliced thicker or cut into various shapes, according to the recipe. Sprouts may be served alone, drained, with butter melted over them, after boiling for about twenty minutes. Salt is added near the end of the boiling period. If the fresh sprouts are unpleasantly bitter to the taste, there should be a change of water after the first ten minutes of cooking. The more pronounced bitterness of some of the tropical edible bamboos (of the genus *Bambusa* and others) may be removed by a third change of water if the bamboo is not sliced too thick and a good volume of water is used."⁵²



Scalloped bamboo.

3 cups parboiled	1 teaspoon salt
sliced bamboo	4 tablespoons
4 tablespoons butter	grated cheese
4 tablespoons flour	paprika

Place the bamboo in a greased shallow baking dish. Prepare a sauce of the butter, flour, milk, and salt; then blend in the cheese. Pour this over the bamboo and bake in an oven at about 350°F for 30 minutes. Serve with paprika sprinkled over the top.

Sautéed bamboo.

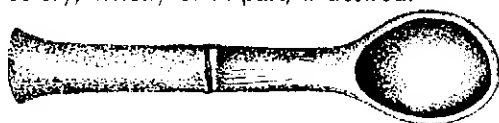
2 tablespoons butter	1 teaspoon salt
or other fat	pepper
3 cups sliced	
parboiled bamboo	

Heat the fat in a frying pan, add the bamboo, sauté for about 5 minutes until slightly brown, and stir occasionally. Add the seasoning and serve on hot cooked rice with a cheese sauce.

Bamboo potato salad.

2 cups diced cooked potatoes	1 cup finely cut parboiled bamboo
1½ teaspoons salt	2 teaspoons chopped onion
½ cup French dressing	1 cup salad dressing
1 cup finely cut celery	½ cup diced cucumber

Add the salt and French dressing to the potatoes and chill. Add the celery, bamboo, onion, and cooked salad dressing. Mix together carefully to avoid breaking the potato. Add the cucumber and serve on crisp lettuce. Bamboo may also replace the celery, wholly or in part, if desired.



SPROUT FOOD VALUE. The food value of bamboo sprouts is roughly equal to that of an onion, with the following composition per 100 grams in the case of *P. edulis*. (One ounce = twenty-eight grams.) Values for fresh sprouts are followed by figures for the canned product: crude protein, 2.5 g, 1.9 g; crude fat, 0.2 g, 0.1 g; carbohydrates: sugar, 2.9 g, 2.9 g; crude fiber, 1.0 g, 1.8 g; water content, 92.5 percent, 92.8 percent; calories 23, 20; ash, 0.7 g, 0.4 g; lime, 1 mg, 1 mg; phosphorus, 43 mg, 26 mg; iron, 7 mg, 1 mg; vitamins: A, 50 iu, 50 iu. B-1, 0.10 mg, 0.5 mg. B-2, 0.08 mg, 0.05 mg. C, 10 mg, 0 mg.⁵³ Slightly different figures are given by Leung for unspecified *Bambusa* and *Phyllostachys* species.⁵⁴

HAY AND FORAGE. The horses of the Chinese imperial stables were fed on bamboo leaves, which—half a world away—Jamaican exports regard as a “hard” forage conferring superior physical tone and stamina on horses compared with animals raised exclusively on succulent grasses. A favorite food of many wild animals—elephants and buffalo in India, pandas in China, and gorillas in Zaire, to name a few—bamboo provides relished feed for cattle, sheep, and horses to farmers all over the world where the plant abounds. *A. gigantea*, one of two bamboos native to the continental United States, is the highest yielding native range in its land of birth. Other species make significant contributions to animal food needs elsewhere. Among fifty-two species discussed by McClure, some of the more significant include the following.⁵⁵

B. arundinacea is listed by Indian government

publications as one of the fourteen most important shrub and trees for fodder in India and Ceylon.⁵⁶ It is unfortunately poisonous to livestock when new shoots are small and contain lethal amounts of hydrocyanic acid.

B. ventricosa has shown a remarkable tolerance for drought during severe dry seasons when it produces “an astonishing mass of succulent foliage.” As such, McClure recommends it for trial as a forage in areas with prolonged dry seasons.⁵⁷

B. vulgaris leaves are a valuable feed, very rich in nitrogenous material, eaten with zest by cattle and horses. Cut to the ground, clumps spring up again rapidly, providing abundant forage. Cattle fed on it during long dry periods equaled the condition of those fed ordinary fodder, and bamboo leaves of this species are claimed to make for more resistant horses. Dried leaves of *B. vulgaris* and *B. ventricosa* have been found an excellent source of vitamin A in chick rations.⁵⁸ In spite of hydrocyanic acid found in young shoots of *B. vulgaris*, there are no reports of cattle poisoning. Various species of *Chusquea* have local importance in many areas for forage in South America. In India a three-year plantation of *D. strictus* yielded 19½ tons of fodder per acre, which proper management could increase to 40–60 tons. The spear grass commonly found on equivalent soil was producing 1½–2 tons of green fodder per acre. The green leaves of *D. strictus*, supposedly curative for certain animal ailments, are fed to cattle and ponies with broken wind or hoof and mouth disease.

Of the *Phyllostachys* species, trimmings from all those at the Savannah, Georgia, groves of the USDA were routinely fed to cattle and mules. *Sasa paniculata* is used as pasture for horses and sheep in Japan.

The chemical composition of bamboo leaves varies through the year. Their nitrogen content diminishes from May to October, for example, from as much as 25.8 percent to 6.6 percent.

Analyses of *A. tecta* in North Carolina revealed great changes in amounts of crude protein, calcium, and phosphorus. Digestibility of bamboo leaves diminishes with age.

Bamboo shoots are routinely protected from cattle, for the sake of both the animals and the grove, since several species of bamboo have sufficiently high concentration of hydrocyanic acid for 5–10 ounces of their shoots to kill a full-grown cow within two hours. Boiling quickly rids sliced shoots of cyanogens; there is no fear of poisoning people from cooked shoots.⁵⁹

ONCE UPON A TREE.

Forest-field-plow-desert: that is the cycle of hills under most plow agriculture. Field wash, in the United States, Latin America, Africa, and many other parts of the world, is the greatest and most menacing of all resource wastes. We are destroying our soil faster and in greater quantity than has ever been done by any group of people at any time in the history of the world.⁶⁰

So many problems are pounding on the door of human history, it hangs loose on the hinges; but among the more insistent are food, fuel, and water shortages, all related intimately to soil loss. We have spoken of firewood's relation to the present ecological disasters on the earth.⁶¹ "Eckholm [*Lossing Ground*, 1976] sees the shortage of firewood as a central feature of this crisis. The uncontrolled clearing of remaining or replanted trees has its severe ramifications: Precious topsoil erodes not in centuries as in the past, but practically overnight; a disastrous increase in flooding occurs on lowland plains; and new deserts and grass wildernesses are created in drier zones by inhabitants removing the remaining ground cover. Economic development projects in Africa, Asia, and Latin America are now dimmed by accelerating destruction of the land's productivity. Slash and burn shifting cultivation has in many places increased beyond the ability of the sensitive forest to recover. Massive forest-clearing operations by governments and corporations in places such as the Amazon river basin and Borneo are often followed by heavy grazing, which completes the land's destruction."⁶²

HAMBURGER HUNTERS: MEAT YOUR MAKER.

For Africa, estimated meat production fell to one-sixtieth its natural level when we cleared, fenced, ploughed, sowed pasture and introduced exotic cattle. In Australia, we find one grazier barely existing on lands that supported two to three hundred Aborigines.⁶³

World woods are being lost for a number of reasons—inefficient cook stove design, increasing populations increasingly "civilized"—that is, requiring more packages, Kleenex, and newspapers. Each Sunday edition of the *New York Times* knocks down 140 acres of forest. But a major reason in many areas for forest loss—and bamboo grove destruction—is the hamburger hunters. Humanity's addiction to dead cows, the idea that being made of meat we need it to survive helps create drastic



Four of these are bacteria-burgers, four real hamburgers. Can you tell the difference? Correct answers will be found in a fortune cookie under the plate.

changes over large areas of the earth's surface. These changes effectively reduce protein production, dramatically alter weather, augment erosion, extinguish habitats, accelerate extinction of species . . . and human tribes. Many effects more messy than cow pies fall in the wake of the herd. Meat, in the modern world, is not an "everybody idea," not a feasible planetary norm.

"The energy content of the food on the McDonald's menu is just one tenth the energy expended to get it from farm to consumer. The reverse is true in a primitive society of subsistence farmers in New Guinea. They get sixteen times more energy from the vegetables they raise than the human energy used in farming and cooking them. Their farm produce goes almost directly into their mouths, without ever being machine-stamped into 1.6-ounce hamburger patties 3.875 inches wide, quick frozen, shipped great distances, grilled and neatly packaged in a paper box. Only in America and other affluent countries does food take such a long, energy-wasting route to the consumer."⁶⁴

Even in revolutionary countries committed to feeding all, governments often find it hard to revolutionize the mass diet, adjust it to necessities imposed by present population densities and to the possibilities offered by technologies that are known but unenacted. It's interesting, for example, that the biggest mammals eat the smallest lunch. Whales, the size of a house and a half, feed on plankton as small as the words on this page. The human race, a quarrelsome giant on the planet now, could take a hint from this fact of nature. The most bulky thing we eat, a steer, is the least efficient crop we have



*"Daniel Boone, the deer-skin man
needing land or fuel for
free,
took his gun and axe in
hand
felled an Indian or a tree
..."*
—Popular ballad.

ECOPROTECTION

Revegetation: heal thy planet.

By nature man is a forest dweller. He was cradled in the tropics. His food was the fruit of trees. In his forest setting man was conscious of his unity with all living things. The memory of that Golden Age has come down through the ancient Egyptians, the earlier Greeks, the Aztecs, and is told in the folk-lore of African peoples of today. The paradise or garden was a clearing in the forest where gourds and other vegetables were grown. The folk-lore and legends of the Golden Age echo the scriptures of many religions and show that trouble first came when man forsook the garden culture and became a herdsman. The traditional "field" or "felled" was a clearing in the forest. In the garden people lived in harmony with Nature and learned to understand the seasons for sowing and harvest, as well as the best ways of storing seed and

food; and from the art of horticulture other forms of culture grew, with seasonal dances.

—St. Barbe Baker

Bamboo is managed by the forestry service in most countries, and in its natural state is a recurrent companion of trees. Any consideration of bamboo use on a significant scale to people now implies a careful look at this larger context of the world's forest use and abuse. As coda to these notes on bamboo, we add a chorus of warnings on the central seriousness of devegetation in our time and the importance of tree and bamboo farming as part of a worldwide effort to revegetate—especially among the young in schools. The uses of bamboo for people are complemented by its uses for the planet, as weather buffer for ecologically vulnerable terrain such as hillsides and riverbanks; as bandage for lands already bruised by human enterprise; as friend of forests and ally of appropriate wilderness.

These pages grew, nourished by a huge hope that we find our way towards a balanced and intimate agriculture, humane and permanently possible, in which the best crop of the kingdom would be not bamboo or any other plant, but we ourselves, the gentle stewards of the earth's sufficiency, complete people. As the Chinese proverb says,

*Complete people grow neither fast nor slow,
like a tree on a mountain—
root by root without rest
gripping the earth more firmly,
leaf by leaf without haste
climbing sky.*

—I Ching, Tree on a Mountain

Earthskin.

Early peoples gradually improved the flowering plants and developed edible grains such as wheat, barley and rye; stores and granaries were erected; fields were enlarged; more and more forest was removed and frequently the water cycle was broken. It took time to recognize the connection between tree cover and the growth of food crops. In the course of centuries people discovered it was easier to raise and graze domesticated animals than to hunt the wild ones. Soon flocks and herds spread over the land. The animals, especially goats, denuded ever-widening areas of trees. In order to protect their flocks the owners hunted for wolves and other predators. When the grass grew sparse they felled more forest, cutting and burning to make new grazing lands. The pressure on the land encouraged hamlets to swell into towns, and towns into cities, where the inhabitants

developed trades and professions, demand for meat increased and crops were diverted to feed animals and walls were built around settlements to keep the animals out.

The Ancients believed that the earth was a sentient being and responded to the behavior of man upon it. As we have no scientific proof to the contrary, should we not accept this point of view and behave accordingly? If a man loses one-third of his skin he dies; the plastic surgeons say, "He's had it." If a tree loses one-third of its bark it dies. This has been proved scientifically by botanists and dendrologists. Would it not be reasonable to suggest that if the earth loses more than a third of its green mantle and tree cover, it will assuredly die? The water table will sink beyond recall and life will become impossible.

—St. Barbe Baker



plant community that is currently being researched more at centers such as Cary Arboretum, in Millbrook, New York.

"With so many benefits to shrub communities, one may wonder why all rights-of-way have not already been converted. Unfortunately, it is more a problem of converting right-of-way managers than converting the plant communities. Most of the present generation of right-of-way managers have been trained at forestry schools that emphasize techniques of growing tall trees quickly, not the low and slow-growing vegetation needed on rights-of-way. Most managers are not eager to have to learn about a whole new discipline, vegetation science."⁶⁷

The possible role of bamboo in that science is, of course, completely unexplored. But shrinking land per person will eventually impose more productive planning on these millions of presently wasted acres. Groves dividing dual-lane highways,



for example, could provide a visual shield for headlights and a soft crash zone where firm-yielding culms would gently brake a speeding vehicle, while providing as well a crop for construction, paper pulp, or schools.

AGROFORESTRY. Some think that we shall never see crops more productive than a tree. "Nothing gives more yet asks less than a tree," remarked Jonathan Chapman, known in his shady wake as Johnny Appleseed. A number of modern agronomists agree: "The 'tool' with greatest potential for feeding people and animals, for regenerating the soil, for restoring water systems, for controlling floods and droughts, for creating more benevolent microclimates and more comfortable and stimulating living conditions for humanity is the tree. In food productivity alone, tree crops can produce ten to fifteen times as much food per acre as field crops."⁶⁸

If much of the tropic forest is to be preserved, we must make use of tree crops. Tree crops will safeguard fertility while producing food for man. In most cases there can be an undergrowth of leguminous nurse crops of small tree and bush to catch nitrogen, hold the soil, make humus and feed the crop trees—nuts, oils, fruits, gums, fibers, even choice weeds (Smith, *Tree Crops: A Permanent Agriculture*, 1950).



It has been predicted that within the next twenty-five to thirty years, most of the humid tropical forest as we know it will be transformed into unproductive land . . . Agroforestry is a sustainable management system for land that increases overall production, combines agricultural crops, tree crops, and forest plants and/or animals simultaneously or sequentially, and applies management practices that are compatible with the cultural patterns of the local population. Trees are the dominant natural vegetation in most of the tropics, and with few exceptions must remain so if the land is to be used for the greatest benefit of man (Bene, *Trees, Food and People: Land Management in the Tropics*, 1977).

Faunavores and Floravores.

How strange it is that communities fail to realize the importance of preserving tree cover on tree slopes. Man has a bad record as a forest destroyer, cutting and burning greedily and recklessly, destroying the built-up fertility that has accumulated through the centuries. He has been skinning the earth alive in his greed and folly and to satisfy his unnatural appetite for the flesh of his fellow creatures.

In some countries, such as the U.S.A., up to three-quarters of the land has been degraded to the use of growing crops to feed animals which they kill to feed themselves. Surely a round-about way of getting food, when it is possible to feed ourselves directly from the earth through fresh vegetables, fruit and nut-bearing trees. It is possible to produce meat and milk direct from the plant kingdom. These foods are not only of better taste, but richer and more

wholesome—easy to prepare and cheaper to use. Above all, everybody who has his own piece of land can easily raise his own raw materials for these foods on his own land.

Village communities of the future, living in valleys protected by sheltering trees on the high ground, will have fruit and nut orchards, live free from disease and enjoy leisure, liberty and justice for all, with a sense of their one-ness with the earth and all living things.

Under existing systems food looms large and there is a constant threat of famine over wide areas, but if we treat reforestation as seriously as we do national defence, and turn from an animal economy to a sylvan one, we shall be able to look forward confidently to the time when food will worry us as little as the air we breathe.

—St. Barbe Baker

for protein production. A "diet for a small planet" with a big family might sensibly eat more bugs and fewer cows. Half the world's people have nothing to eat tonight but their fingers. None of them are ministers of agriculture. If they were, they'd already be acting on this information, which is already old:

The full potential of protein bacteria is easier to grasp if it is compared to a properly fed 1,000 pound steer. The steer stores up just 1 pound of protein a day. In the same 24 hours, a half ton of selected microorganisms, feeding on oil, increase in size and weight by five times, and half this gain is useful protein. While the steer is making 1 pound of protein, the bacteria-in-oil produces 2,500. The line of meatlike, meatless foods includes ham, sausage, frankfurters, chicken, steaks, meat loaf, chipped beef, and luncheon loaves. They have no bones, skin, or excess fat. Surprisingly, most of these rated high both in taste and appearance.⁶⁵

MONSTER MAKERS: INAPPROPRIATE TECHNOLOGY.

In the United States and other hyperdeveloped countries, herbicides are another major source of devegetation. The area under transmission lines of utility companies in the United States, for example, adds up to some 32,000 square miles, equal in size to the combined areas of the five states of Massachusetts, New Hampshire, Vermont, Connecticut, and Rhode Island. One tall tree beneath the wires can interrupt the power cables, so right-of-way managers in the past have dumped on the ground beneath them each year 4 million pounds of 2,4,5-T, a herbicide that was the major component of Agent Orange, the dreadful defoliant used in Viet-

nam. This herbicide contains dioxin, one of the most toxic of all manmade substances, identified as a cause of liver cancer. It is also a "teratogen" or "monster maker": Its use was temporarily suspended by the Environmental Protection Agency on rights-of-way, pastures, and forest lands in 1979 as a result of a sudden rise in miscarriages and birth defects in Oregon, where it was sprayed on forests before planting Douglas fir and other evergreen seedlings. Oddly enough, the use of 2,4,5-T on croplands and rangelands was not prohibited by this partial ban.

STABLE LOW-SHRUB COMMUNITIES. Highways, railroads, and pipelines are other open spaces controlled by herbicides in the United States—a total area of some 200,000 square miles or 34 million acres. An alternative to this chemical control is described by Tillman (1979): the establishment of stable low-shrub communities that are nonpollutant and aesthetically pleasing. They encourage wildlife by providing food and cover not available in forests or grasslands and offer greater erosion control with roots deeper than grasses. "Many plants have been identified as being good components of a stable low-growth community. Sumac, various dogwoods, viburnums, small willows, sweet fern, snowberry, blueberry, blackberry, and bear oak are examples of desirable shrubs. Goldenrod, meadow fescue, bluestem grasses and bracken fern are favored herbaceous species."⁶⁶ Allelopathy, the production by plants of chemicals that inhibit growth of other plants around them, is one mechanism responsible for creation of a stable, low-growing

the ground from pounding rain. Dead, a 4-inch annual leaf fall equal in weight to the new growth of culms in some species, clogs the small ditches where erosion starts. The 2–4-inch mulch bamboo leaves create makes it easier for earth to drink and hold water while increasing its organic content—the depletion of which is a major cause of man-made erosion. Finally, the harvest of bamboo does not disturb the soil surface, a distinct advantage for a hillside crop. Hexagonal plantings 15 feet or less apart are recommended rather than square patterns on inclined land since they break the flow of water more.

Researchers in Puerto Rico found bamboo (*B. vulgaris*) as good or better than any other plant for controlling landslides above and below the winding roads that wander her mountainous interior. A river there periodically devastated chunks of trial fields at the Mayaguez Federal Experiment Station. Bamboo revetments at critically sharp curves, backed by plantings of living clumps, effectively solved the problem. "The fibrous mass of roots binds the soft banks, and the thick culms arrest strong currents during flood periods."⁷⁵

The constant moisture of stream banks fortifies bamboo's growth and consequent capacity to hold the ground against the current. Streamside locations for bamboo are particularly recommended in areas with a pronounced dry season.

B. vulgaris is effective in erosion control and is among the easiest bamboos to propagate in frost-free areas. But other species, more resistant to ravages of powder post beetles in harvested culms, are preferred as a more useful crop. These include *B. textilis*, *B. tulda*, *B. longispiculata*, and *B. tuldoides* among clumping, tropical bamboos. Among monopodial species, *A. humilis*, *A. vagans*, and *S.*



pumila are especially recommended to resist erosion. See descriptions of separate species for other good soil-stitching species.

FRIEND OF THE WOODS. We have noted that bamboo likes the neighborhood of trees. Trees also find bamboo a companionable plant in the forest. The friend of the people in China, in India, the wood of the poor, bamboo is also recognized in both countries as the friend of the woods and watersheds. In Colombia, species of *guadua* growing on steep lands keep many million tons of mountains from becoming river bottom, delta, and ocean floor. (See p. 124.) This report of positive ecological impact comes from Dehra Dun: "Understory plants like bamboo, particularly in present deteriorating ecological conditions, can help a lot to maintain continuity of nutrient cycle for sustained fertility in extensive areas of Indian forests. Bamboo leaf fall, particularly in fire-free season, builds humus. Moderate shade of bamboo suppresses dense bush and shrub shaders, enemies of timber species seedlings. Their high canopy of foliage also helps conserve moisture so bamboos have performed a remarkable role in the regeneration of important timber species like teak in the semimoist and moist teak forests of Madhya Pradesh. In these areas, under patronage of the bamboos, teak is slowly but steadily increasing. Sal seedlings in Balaghat forests of M.P. also enjoy higher survival where bamboos are prevalent."

"The notion that shallow rooted and self-thinned bamboos can mar the regeneration of timber species is not backed by the concept of origin and succession of vegetation. Especially in present-day fast changing environmental conditions in forests—with heavy logging, frequent fires, grazing, and recent intensive use of bamboos—the bamboos offer no threat to the environment. On the contrary, they deserve to be preserved and propagated with great care and vigor."⁷⁶ There are re-

But we mustn't forget the forest in the trees. Any natural forest is a community of many species creating a symbiotic blanket of life, woven of many plants and animals. A broader notion than "reforestation" is required.

Revegetation is a concept that needs wider circulation. The planting of many different suitable types and sizes of vegetation makes the widest possible use of the capacity of a landscape to support life. A wide range of plant life also further expands the amount and diversity of animal life that the area can support, and this includes the human animal. A community of plants composed almost solely of trees ignores the potential that shrubs and ground covers can contribute to the productivity of a landscape: animal life, both wild (deer and fowl, for instance) and domestic (such as pigs, cattle, and geese) will not do as well when there are only trees. *Reforestation* usually creates a place for humans to come and get lumber and firewood and little else. *Revegetation* creates a place for a greater variety of plants and a larger number of animals, including humans, to live . . . and provides lumber and firewood too (Weber, *Reforestation in Arid Lands*, 1977).⁶⁹ Reforestation programs are part of larger conservation efforts. Increasingly they are being conducted with the realization that it is very difficult to separate reforestation from other revegetation efforts—range management, sand stabilization and similar activities.⁷⁰

ECOSCAB. Recent studies of the ecology of bamboo in the East have cast an interesting light on its possible future in South America.⁷¹ Research suggests that bamboo functions as a healing scab for gashes on the planet. It has already swarmed tall and green over gutted areas of Vietnam defoliated during the war there and appears to have flourished, historically, in the wake of man's shifting agriculture throughout the East. In Thailand, for example, bamboo replaces the cleared teak forests. Bamboo is less prevalent in South America, according to this view, fundamentally because of the ancient harmony of the native population with the forest, which did not suffer large-scale clearings until after the arrival of Europeans. In the present destruction of the original forests, particularly in the Amazon, men may unwittingly be clearing for bamboo, in the long run. Its rhizomes are more tenacious and insistent than our shifting purposes.

In their excellent survey of bamboo, Smithsonian Institution botanists Thomas Soderstrom and Cleofe Calderon suggest that we can look to the oriental past for the role of bamboo in South Amer-

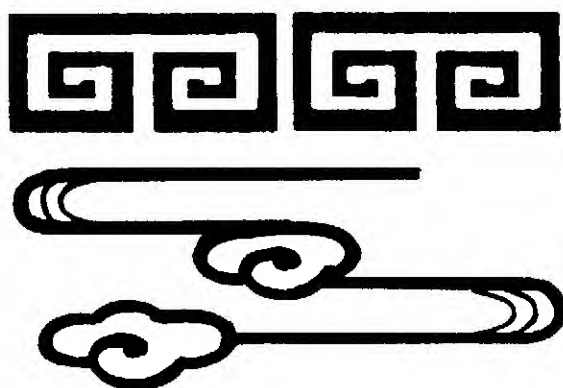
ica's future: "In the Old World, man found that as his primary forests diminished, one plant above all filled his many needs, the native bamboo."⁷²

EROSION CONTROL. Flood tamer, soil builder and saver, windbreak and earthquake refuge, companion of forests—bamboo's effects form a litany of positive ecological roles. "Bamboo forests prevent landslides and washouts. They protect riverbanks. On July 5 of this year, 1972, typhoons hit Shikoku's Kochi Prefecture [Japan] and in the resultant landslides some sixty-four people were buried alive in their houses. No bamboos were growing in the disaster areas, and no damage occurred in places planted with bamboo . . . The vitality of the plant is well attested to by the popular injunction to flee into a bamboo grove in an emergency such as an earthquake or typhoon."⁷³



The emergency has become permanent in the ecological decadence—the "decology"—of our time. Crisis is our habitat. The earth under our mismanagement is trembling like a wounded animal, as a survivor of the 1972 Managua earthquake said of the havoc there that claimed 100,000 lives. Bamboo recommends itself to dress the wound because of its rapid growth; its vigor on hillsides where ecological deterioration is most severe; the density of its rhizomes binding soil; its massive foliage braking rain, gentling sun, preserving moisture, and building humus; and for the multiplicity of its use.

A roaming mass of roots and interlocking rhizomes—up to 85 percent in the critical top foot of earth—hold firm even in earthquakes. Living, the bamboo leaves form a leaky umbrella that shields

**ECOLOGICAL LULLABY**

*Rock-a-bye raincloud
on a woods' back,
where the oak grows
the thunder will crack.
Where the bough creaks
the weathers will fall,
and up will leap flower
and forest and all.*

*Rock-a-bye hillside
gnawed to the bone,
where the herd grazes
grasses will groan.
Where the plow plunders
gullies will crawl,
and off will run tillage
and village and all.*

*Rock-a-bye rainbow
on a cloud cap,
where the rose blows,
the lightnings will clap.
Where the root wanders
waters will stall—
and soon'll shoot daisies
and crazies and all.*



China's present intense effort to retree herself confirms the primitive belief that fecundity of life on all levels, including human reproduction, is intimately linked to the holy groves around the village.

BIRTHDAY PLANTINGS. One of the most persistent and widespread rituals of the cult of trees is the practice of planting them to mark human birth and death. The Maoris bury the umbilical cord in a sacred place and plant a young sapling over it. The child will dwindle or flourish in sympathetic response to the tree's vitality and die with it as well. In Aargau, Switzerland, an apple tree is planted for a boy, a pear tree for a girl. In Mecklenburg, the afterbirth is placed at the foot of a young tree, with which the child then grows.⁸⁰ For a wealth of tree tales, see Frazer, *The Golden Bough* (chapters 9, 10, 15, 67.2), on tree worship, its remnants in modern Europe, the particular worship of the oak, the "external soul" of people in plants—many a curious legend on the divine rights and powers of trees.

The practice of planting a tree on the birth of each child should be expanded to keep pace with current rates of deforestation per capita. We are losing 1 acre per minute of tropical forests. A tree could be routinely planted by all earth peoples each birthday. Large cities should plan reforestation zones upwind of their bad air, birthday-tree picnic areas prepared to receive the planting energies of parties of friends as a standard ceremony in the culture. Bamboo and other valuable plants could be included as an option to more familiar tree species.

GREEN CHINA. China and South Korea are unique among nations in having reversed deforestation, demonstrating to the rest of us that it can be done. The 1978 publication of FAO, *China: Forestry Support for Agriculture*, reports on a study tour in 1977 analyzing the Chinese integration of forestry and farming: "Striken by a series of natural calamities throughout history, China appears determined to tame rivers, regulate water systems, reverse soil erosion, establish a favorable climatological balance and thus banish the feeling of helplessness against natural disasters. Forestry has played a major role in achieving these objectives.

"The participation of the people has been a central concept in China's forestry efforts. Research concentrates on practical problems and includes commune members; much is learned from the practical experiences of field workers. Education of the people is seen as a requirement of successful

ports from several countries of local species of bamboo in competition with trees. Others, like *Sasa kurilensis* in northern Japan, hinder the work of foresters.⁷⁷ Such reports are few in bamboo literature, and the problems described are avoidable in future Western plantings, in which species will be chosen rather than simply presented by the landscape.

THE CLOUDY BOUGH: TREE WORSHIP AND WEATHER CONTROL.

Then they cut down our lemon trees
And the Spring fell from our eyes!
—Mahmud Darwish⁷⁸

"In the religious history of the Aryan race in Europe, the worship of trees has played an important part. Nothing could be more natural. For at the dawn of history Europe was covered with immense primeval forests. . . . In the forest of Arden [England] it was said that down to modern times a squirrel might leap from tree to tree for nearly the whole length of Warwickshire. . . . Amongst the Germans the oldest sanctuaries were natural woods. Sacred groves were common and tree-worship is hardly extinct amongst their descendants at the present day. How serious that worship was in former times may be gathered from the ferocious penalty appointed by the old German laws for such as dared to peel the bark of a standing tree. The culprit's navel was to be cut out and nailed to the part of the tree which he had peeled, and he was to be driven round and round the tree till all his guts were wound about its trunk. It was a life for a life . . . Worship of trees was prominent among the Lithuanians, at the time of their conversion to Christianity towards the close of the fourteenth century. Some of them revered remarkable oaks and other great shady trees, from which they received oracular responses . . . In the forum, the busy center of Roman life, the sacred fig tree of Romulus was worshipped down to the days of the empire, and the withering of its trunk was enough to spread consternation through the city."⁷⁹

The physical tree was regarded first as the body, later as the dwelling of the tree spirit. Trees were widely believed to give rain, control weather, encourage crops, increase herds and the fertility of women. Our Christmas trees are a remote vestige of these feelings. The practice of bringing an evergreen into the house at the deepest, darkest valley of the year, the winter solstice, is a custom with many variants depending on climate and available



flora. The constant in all cultures is the belief that the tree, the tallest and most massive life form in the experience of all peoples, is intimately linked with the regenerative powers of life. Modern findings in meteorology and agroforestry confirm ancient feelings about the central role of trees in biosphere maintenance and the health of human cultures. Conclusions of the ancient tree-worshippers and contemporary ecologists differ not in essence but in expression. In myth or statistic, both acknowledge the crucial place of trees in the fabric of planet life and atmosphere. The Greeks made Zeus the god of both oak and rain. The Chinese, in the *I Ching*, established a family of images, a periodic table of the elements of change in people and the natural world: Father Sky, Mother Earth, and their six sons and daughters: Thunder, Water, and Mountain the sons; Wood-Wind, Fire, and Lake the daughters. Yoking wood and wind in the eldest daughter is an example of the intuition of all early cultures that trees had a good deal to do with weather control. FAO's 1978 study of the agricultural benefits of

Ecological activists.

The angel cried with a loud voice, saying,
Hurt not the earth, neither the sea, nor the
trees.

—Revelation 7:3

At long last I am beginning to see a tree sense coming into being all over the world. The foresters of China have made a shelter belt 680 miles long to stop the sands of the Gobi Desert spreading into China proper, and the Old Wall of China is becoming a tree wall stretching for 2,000 miles. Millions of little trees like a green mist stretch as far as the eye can see on either

side of that great rugged wall. Latest reports indicate that as many as thirty-two million people are employed permanently in afforestation and that during the planting season about half of the white-collar brigade in the cities don their oldest clothes and go out into the country to help the peasants plant trees on the mountain-sides.

Peking, which was once treeless, has now become a city of trees with avenues comprised of up to ten rows of trees. The latest reports show that tree cover has been increased from 7 percent to 27 percent.

—St. Barbe Baker

tree planting programs.⁸¹ As a result, the average Chinese is much more knowledgeable about forestry than the average person in any other country, and protection of reforested areas is not a problem. Forested lands have doubled since 1949. Tree planting has had direct economic benefits in the form of timber, fuel wood, livestock fodder, fruit, and other products. In some areas, shelter-belt forestry is considered the primary factor in dramatic agricultural gains, ahead of irrigation, fertilization, and improved seeds."⁸²

The FAO group also concluded that countries with only a professional forest service on wages could never match the committed work force of the people of China, where tree planting, everywhere, is everyone's labor of conscious love.

Two is not too early to begin training ecological activists. Chinese children's stories are an interesting study in how she shapes her citizens at an impressionable age, providing positive social models for little children before they can even read. Main themes include: clever analysis of everyday problems, often through homespun, shoestring



Paper tractor. Contemporary Chinese papercuts feature tractors, and power transmission lines stepping over mountains in the misty distance of landscapes. In China, a deep and long cultural respect for nature and for traditions has prompted a judicious grafting of modern methods onto the tao of native farming as practiced for centuries. The Chinese are feeding their people, re-leafing their cities, restoring their land, and doubling rather than diminishing their forests.

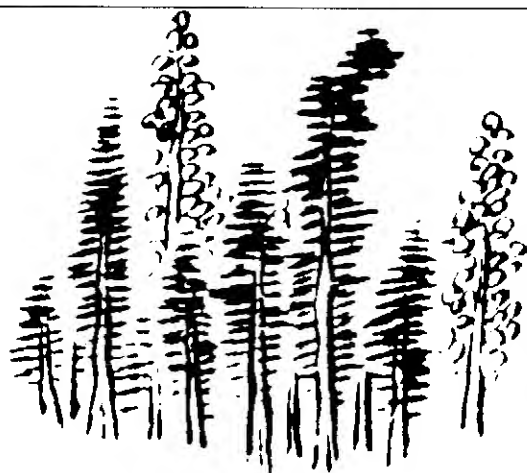


Green Guerrillas

Tree-planting is closely associated with the love of one's country and it is interesting to see that in People's China the care and planting of trees has become the main pastime in the schools and recreation over the weekends for perhaps the greater part of the population. To inspire this there must be widespread education in trees' biological contribution to life, a sympathetic feeling for the earth, and a desire to restore its green mantle. I have indications that there is a growing desire throughout the world to co-operate in a gigantic tree-planting programme not only in the Sahara but in a green belt to encircle the globe.

Of the earth's 30 billion acres, already more than 9 billion acres are desert. Land is being lost to agriculture and forestry much faster than it is being reclaimed. At the same time the world population is exploding. Already half the human family is on the verge of starvation, for man breeds and lives beyond the limits of the land. Yet if the armies of the world, now numbering twenty-two million, could be re-deployed in planting in the desert, in eight years a hundred million people could be rehabilitated and supplied with protein-rich food grown from virgin sand.

—St. Barbe Baker



scientific experiments; friendship rather than competition in sports; self-reliance in personal cleanliness; study before play; alert concern for the comforts and convenience of others; a brisk readiness to learn from old people and share care of children younger than oneself; offering alternatives instead of merely criticizing; returning lost objects promptly and repairing old toys; sharing resources and working cheerfully—"everyone wants the heavy load."⁸³ It is instructive to compare Chinese child models—in which cooperation is the constant moral—with the violent justice and clenched face of U.S. comic superheroes, in which hyperachievers display miraculous and intensely personal powers to an astonished multitude of helpless spectators. Which town has the tantrum most deeply programmed into its early consciousness? What harvest will such a social psychology reap—or rape—from the earth around us?

Along with all the civic virtues, mentioned above, Chinese children's books include revegetation. A wordless series of drawings for prereaders pictures a collaborative tree planting by grade-school green guerillas, who complete their task, wave goodbye to one another, and head their separate ways home. En route, the child we're following has his hat blown off in a wind—and remembers the saplings, left in the wind without supports. He arrives back at the planting site just as the rest are returning to stake the young saplings—with bamboo. The story provides a tidy parable, for just as forestry is integrated with agriculture and supports it in China, bamboo complements and supports their intensive agroforestry. As a part of reforestation, China is committed to rebamboo.

FAO REPORT.

Bamboo is one of the major cash crops planned for planting widely. An indication of the potential

of bamboo cultivation is found in Chairman Mao's instruction to research stations to carry out research on the acclimatization of southern bamboo species to the ecological conditions of northern China.⁸⁴

A sample production brigade of 750 hectares (1,650 acres) grows 500 hectares (1,100 acres) of an unmentioned species—the context suggests moso, *P. pubescens*—with a density of 2,400 stems per hectare (1,090 per acre). Around 75 tons of organic manure are applied per acre. Exploitation begins seven years after planting in selective cutting limited to culms five years old, with two thirds of the grove usually left unharvested. The average shooting/stem ratio is about 0.8 shoot per culm after five years. One commune performed yield experiments: 24 culms of *P. pubescens* planted and tended twelve years increased to 3,200, a shooting ratio calculated at 0.6 shoot per culm up to nine years, when it dropped to 0.5. At this rate, 2,400 culms per hectare would produce 1,440 shoots. Selective cutting of one third the grove would yield 800 culms yearly. (FAO 1978.)

EPILOGUE

The Great Disorder.

Shu ruled the South Ocean, Hu the North. They often met to do business in the Center, where Chaos ran a traveler's tavern called The Great Disorder. He fed and sheltered them so well that Shu said to Hu: "We have seven holes to see, hear, breathe, and eat. This poor fellow has none. One good turn deserves another. Let's repay his kindness by helping him out." They set busily about and drilled one hole each day. At week's end, Chaos died.

—Chuang Tzu⁸⁵

Not doing—*wu wei*—is a Taoist term for that spontaneous and organic doing of the natural order that brought us here and holds our bones when we die. It is outside as well as inside: It whirls galaxies, pumps your lungs, and knits the eyes of embryos in the midnight womb. Human efforts to "conquer nature," bully the breasts of Mother Earth into more quarts of yield, have consistently produced short-term profit for a few, followed by a long-term mess for the many to correct or endure.

*A great disorder is an order.
A violent order is a great disorder.*⁸⁶

Alert to the sad havoc wreaked by the violent orders of the chemical tractor in half a century of



industrialized farming, appalled at the accelerating extinction of species and peoples, the multiple fouling of lake and stream, the shocking rate of topsoil depletion—many concerned citizens of the biosphere are reevolving the design of an agriculture permanently viable, a sane and stable “permaculture” in harmony with the orders of light and leaf encompassing our human disorders. The principle harvest of permaculture is enlightened farmers capable of sustaining it, delicately tuned to climate and soil, selecting the sanest traditions of the dead, feeding the living with a healthy sufficiency for all, and leaving for the unborn down history from our brief stewardship a still more fertile and handsome planet than we found.

Natural rhythms, life patterns of other species, are not eternal; but they are at least much older than the human race and can provide models of duration for those trying to glimpse the shape of a possible permaculture. “Tempeculture,” however, is ruled by ticking time and imagined temporal advantage rather than eternal laws. Its short-range goals remain ecologically reckless of consequences downstream from its ecofolly. “After us the deluge . . . or dustbowl.” People and planet are plundered with the same ruthlessness. In contrast to the respect for time’s rhythms, which characterizes permaculture, tempeculture impatiently sacrifices steady, prolonged yield for instant profit. The fairy tale of the man who killed the goose laying the daily egg of gold in hopes of harvesting all dozens at once is a fit parable for modern farming. Its advocates have had time to prove that, in agriculture as in art, rush is the mother of ugly.

The most important question in assessing agricultural systems is whether yields are sustainable over long periods and do not overtax

the land’s capacity to continue producing for succeeding generations. Traditional manual and organic horticultural methods in the Orient have for over forty centuries shown dramatic results, managing to feed 1.5 to 2 times more people per hectare than industrialized farming now does using mechanized chemical techniques.⁸⁷

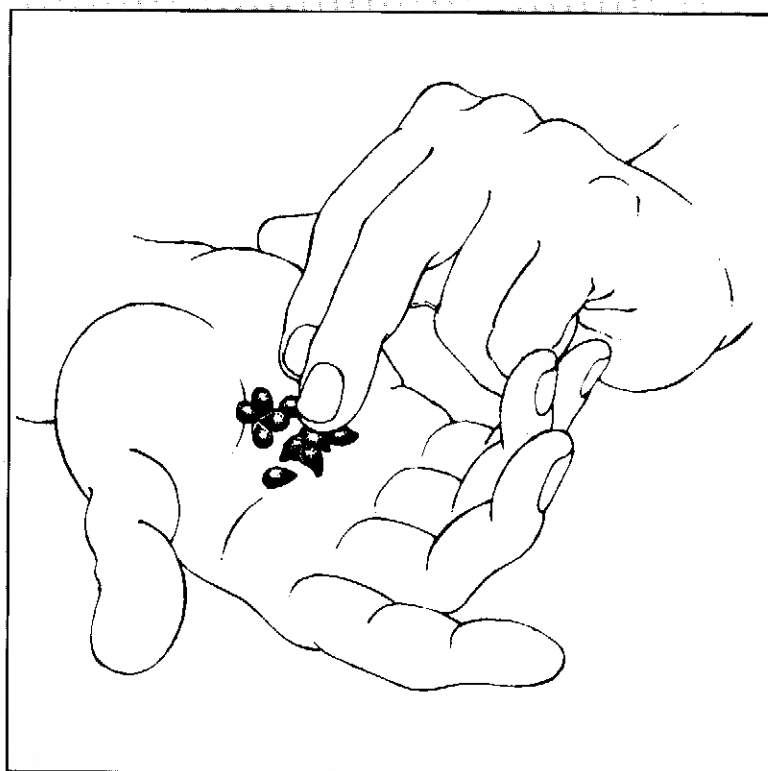
Permaculture lasts as long as we will last. It is a “whole-systems” approach to agriculture allowing nature to do most of the work and people to do most of the harvesting: working with rather than against nature, cyclic renewal replacing linear exploitation, long and thoughtful observation replacing long and thoughtless toil; looking at plants and animals in all their functions rather than treating any as a single product system; meeting human needs with respect for the finite resources of the earth.

Permaculture stores rainfall, accumulates energy reserves, and creates new microclimates that add useful species. Tree crops, edible landscaping, biological pest control, organic waste recycling, the agricultural forest, and revegetation—these are themes related to the configuration of acts and attitudes that make up permaculture. Like a good move in chess, permaculture designs maximal functional connections. Multiuse species create nutrient cycles, food chains, and successional trends that work together to give *sustainable yields*.⁸⁸

The place of bamboo in such a permanent balance of earth resource and human need has been the meditation of these pages. It is, perhaps, significant that some of the most mature and permanent agricultures on the earth’s surface have been those most closely woven with bamboo cultivation and use.

THE CROP OF PERMACULTURE IS COMPLETE PEOPLE. “The bigger the job, the greater the challenge, the

- sulfate, and sulfite pulping processes, or the intricate mysteries of comminution, bleaching, and digesting are likely to be an excess of riches. Fortunately, none of this is necessary to understand how and why bamboo has assumed increasing importance in the industry of papermaking. Sineath 1953:24-54 provides an excellent summary of technical matters on paper production for those equipped or concerned to dive deeper into that data vat.
44. Sineath 1953:27. Austin 1970:201. Varmah 1980:13.
 45. FAO 1978.
 46. Varmah 1980:21-2.
 47. Kiang 1973:18-21.
 48. The directions for making paper are mainly from Sargeant 1976, a recommended how-to. Directions for papermaking are included in many general crafts books now. This is a hopeful trend: perhaps we can soon expect papermaking to be a regular component of early education in the West.
 49. Soderstrom 1979a:166. His figure should perhaps be 15, however; it conflicts with Lessard 1980:56.
 50. Lessard 1980:56.
 51. Ibid.: 109-10.
 52. USDA pamphlet, "Edible Bamboo Sprouts," undated.
 53. Ueda 1960:56.
 54. Leung 1952:18.
 55. McClure 1958:609-44.
 56. Semple 1952:134.
 57. McClure 1958a:614.
 58. Squibb 1953:2.
 59. McClure 1958b:57.
 60. Smith 1950.
 61. See "firewood," pp. 37-40.
 62. Darrow 1981:76.
 63. Mollison 1979:1.
 64. *San Francisco Examiner*, 12 November 1972. Via *Shelter*.
 65. Papanek 1971: 270-1.
 66. Tillman 1979:13.
 67. Ibid.: 14.
 68. Darrow 1981:77, quoting Douglas, *Forest Farming*, 1976. See Darrow for reviews of most forestry books mentioned.
 69. Quoted in Darrow 1981:500.
 70. Darrow 1981:501.
 71. Drew 1974.
 72. Soderstrom 1979a:164.
 73. Junka 1972:22.
 74. Suzuki 1971.
 75. White 1945:845.
 76. Singh 1969:497.
 77. Lessard 1980:56, 95, 129. See p. 215 for warnings on need of careful selection of species when introducing bamboo in new terrain.
 78. *Palestine*, vol. 9, no. 3, 1983. Back cover photo caption.
 79. Frazer 1922:126-8, condensed vigorously.
 80. Ibid.: 791.
 81. This is in keeping with dialectical farming. "Theory without practice is empty. Practice without theory is blind," Karl Marx.
 82. Darrow 1981:498-9.
 83. *Good Children* and *Little Red Guards* are two picture books from Peking Foreign Language Press that U.S. children seem to like a lot.
 84. FAO 1978:74.
 85. Chuang Tzu. *Field Guides to Enlightenment* (vol. 3), Random Road, Box 666, Bolinas, CA 94924.
 86. Wallace Stevens: slightly altered from "Connoisseur of Chaos," *Poems by Wallace Stevens* (ed. Morse), Vintage, 1959:97.
 87. Darrow 1981:74.
 88. Mollison 1979 provides the name *permaculture* and nearly all of this description.
 89. Fukuoka 1978:115, 119.



10. SOURCES AND DIRECTIONS

*"Only the sun on his shoulder
knows where he has come from,
where he is going,
how he'll return,
well laden with wandering,
another morning by another road."⁰*

BOTANICAL ACTIVISTS

Johnny's Appleseed.

Staring at the seeds in his hand left over from an apple he'd just finished one early morning in Massachusetts, John Chapman realized that if we all planted the seeds of every apple, there would soon grow a durable Eden, enough for everyone. Barefoot, with a sackful of dry apple seeds on his back, cook pot for hat on his head full of dreaming, Johnny—as were so many then around him—moved west.

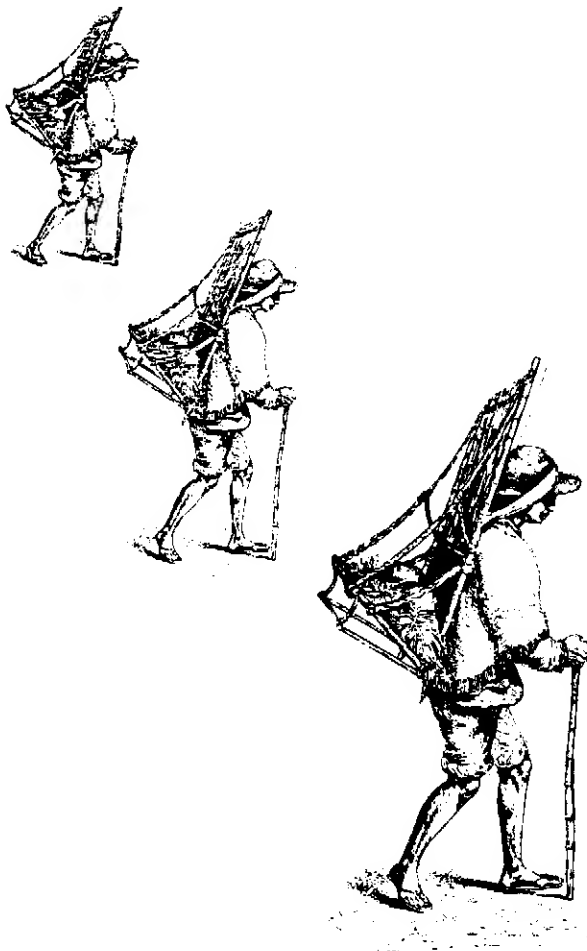
He brought no gun, he sought no fortune: He planted apple seeds, gave small bagfuls to the scattered settlers and stayed weeks on end with little groups of pioneers, helping them to chink the cabin or clear the field as well as plant the orchard . . . and moved on to munch an apple in another wilderness village and to gaze, with an amazement never lost, at the dense wisdom of nature that let him hold the future of a whole healthy hillside in the palm of his hand.

The wet little seeds never lost his respect, however many he handled over how many years. Nobody kept track of either the decades or seeds scat-

tered through them, up and down a thousand valleys, least of all the children who crowded round him, insistent for another and another tale from this magical stranger who kept weaving back through their lives to check his orchards at an ample rhythm.

He romped also with bear cubs in his beloved forest, they say, with the mother watching and enjoying it, gentled in tooth and claw by the subtle alchemy of friendship. Socially, too, he was a bridge uniting what custom drove apart: In a vast countryside where white and Indian feuds and full-scale warfare were the norm, he tried to plant human harmony along with his orchards. Privately, at least, he succeeded: He was loved and welcomed by the Indians everywhere on his wanderings. One bad winter, they found him half frozen in the anxious inspection of some threatened and remote planting of apples and nursed him back to life.

His creative respect for a tiny, unhonored, habitually wasted resource accomplished more with meager means over a wider area and larger population in his time and long after than many a later largely funded-and-staffed government blitz to



"beautify" America—usually mere cosmetic apologies for bad behavior.

His gentle, gardening spirit was antipode to the national habit of belligerence, in family, state, international, and ecological affairs. His economics were closer to Jesus, Francis of Assisi, or the Buddha than to the harsh ring of our national cash register. He played lifetime hookey from success scaled by any common norm. In a nation embracing commerce as fondly as the drunk hugs his jug, he was no more commercial than the wind and weather wrapped around his wanderings or the soil under them.

Chapman, from the Anglo-Saxon *cēap-man*, means "traderman" (*cēap-trade*). Johnny was a chapman with a unique, composite trade of sorts, it's true, and his love for apples was grafted onto a skill at wandering. He was shy of traffic, but was himself a fluid road. So he had the trade and tread to make a merchant—what he lacked was the profit motive. He was a dealer who neither bought nor sold, a peddler of gifts whose wares and person were not for hire for wages, but free for a neigh-

borly asking in any mile of his meander, like a river you can toss a bucket in anywhere and find water.

Bamboo messenger: in green memory of McClure.

*Bamboo, make us an instrument of your peace.
Where you find exhausted asphalt,
let there be . . . bamboo leaves,
drinking weather and sunlight,
sinking back to soil.*

*Let rhizomes wrap the troubled plumbing of our
time,
and may your friends inspire in others
that green excitement (flecked with lemon)
that you stir, alert and trembling in the least
breeze.*

*Let children, learning early your handy magic,
grow old enjoying it.
Let luckiest spirits die in a grove,
nothing between last eyes and April sunlight
but bamboo leaves.*

He left among leaves: McClure died with his obsession on, in his bamboo grove, digging a plant in springtime for a child. He split clean and even, like the plant on which he'd lavished a lifetime of affection, dirt on his hands and knees, busy with a giving errand, April 15, 1970.

Born in 1897, his father a farmer-school-teacher in Ohio, McClure was raised surrounded by living plants, the thousand chores of preindustrial farm life, and neighbors whose fields and beasts rarely left them time to put on airs. After a B.S. in agriculture at Ohio State in 1919, he did not return to the farm as intended. Instead, a spirit rambling as a rhizome led him to China as a lecturer in horticulture in Canton. He loved languages and learned Cantonese well enough to pass as Chinese if heard unseen. Plant collecting in areas with various dialects, he could dismiss his local interpreter within a week. He had been raised among country people, and he moved easily among the peasants of China whom he grew to love as much as he began loving the most omnivisible assistant to their way of life—bamboo.

McClure was accompanied on his plant collecting trips by a tough peasant named Kang Peng (1877–1926), a reformed drinker, gambler, and street fighter who had killed "more than one of his antagonists." Kang Peng was a sturdy assistant, sufficiently seasoned and risk-addicted to wander the mountains of 1920s China, ripe with revolutionaries and thieves, "on the flimsy excuse of collect-

ing and drying plant specimens between papers." He died some six years after McClure's arrival in China, and McClure wrote an "Appreciation" in which he reveals the warmth of their relationship as well as the hardships of companionable plant collecting in that space and time.

"We always shared all things as they came to us—work, food, accommodations, extra burdens, extra sweets. Traveling, as we always did, with minimum baggage and personal effects, we were never able to make ourselves very comfortable. As for beds, or available planks or door-boards for beds, he always set aside the poorest for himself; with food, he was always frugal, never wasteful, in his purchases; nor did he ever take unfair advantage of my desire to provide well for those who worked for me. Spreading the table for a meal, he would always take for himself the broken bowl or the pair of chopsticks that were not mates. When using borrowed bowls and chopsticks, he always remembered to wash and scald them on my account.

"He always took the least attractive food, picked up the most inconvenient odds and ends to carry, and in every imaginable way strove to make my work as easy and as pleasant as possible. Needless to say, I often disputed these attentions, which my superior strength and endurance made unnecessary. But he often won out by sheer insistence."¹

Gradually, over half a century, McClure became a botanical bridge between East and West, between unschooled farmers and the scientific elite, between business and government interests in dozens of countries. He was the ambassador of Bamboo to the human race, locally employed by the Department of Agriculture or other groups for a time, but always actually working simply for bamboo with the plodding patience of the plowboy. His roving eye and trilingual tongue eventually noticed and told more about bamboo in more places than anybody on the planet ever had before. He was noted by friends for his fanatic quest for the precise word and expression, for correcting rather than repeating the errors of earlier research, for getting down to the fundamentals of a subject by taking nothing for granted, and for a lifelong passion for plants and hard work.

Collecting plants and establishing living groves of bamboo for prolonged research and propagation were central aspects of his work, the foundation of everything else. He had six hundred species of bamboo in the Canton groves at Lignan University. They still are flourishing some sixty years after he



began them in the early 1920s. From this collection, the USDA accessioned 250 numbers of living plants between 1924–1940. They were carefully coddled by McClure from China to the USDA groves just south of Savannah, Georgia, from where they were distributed, for fifty years, around the world. This service has been unnecessarily interrupted for nearly twenty years owing to a supposed lack of funds; but a proper design for distribution could easily pay for itself. With the arrival of World War II, McClure's work moved West—with periodic returns to various oriental countries:

During 1943–1944 I made a survey of useful bamboos in the United States, Mexico, Honduras, Colombia, Venezuela, Brazil, and Puerto Rico. . . . The post of field service consultant on bamboo with the USDA (1944–1954) gave me the opportunity to study and collect bamboos in six countries of Central and South America, as well as in India, East Pakistan, and the islands of Java and Luzon. Ultimately I was able to establish living collections of elite economic species in Guatemala, El Salvador, Nicaragua, Costa Rica, Ecuador, and Peru. As consultant on bamboo to Champion Papers, Inc., I made field studies in Jamaica and Trinidad, designed and supervised the establishment of an experimental bamboo plantation in Guatemala, and participated in elaborate studies based on it.²

The Bamboos: A Fresh Perspective (1966) was an attempt to cram the research of a lifetime into three hundred pages and sketch relevant lines of investigation it would take many other skillful lifetimes to complete. Much of the book is intelligi-

Bamboo slaves.

The cheapness of bamboo artifacts imported into the United States has been one of their most attractive features. Bamboo's abundant yield has contributed to their low cost, but the dark shadow of the bargain is the ancient and on-going exploitation of the lowest rung on the economic ladder everywhere. The people dealing closest with the groves, as usual profit from them least. For those who harvest and transport bamboo, the rural poor and unskilled urban workers, bamboo is not a cultural icon, but a life-long cage—with beautiful green bars 10,000 meters tall, when you look at their shadows in an economic light. Basket makers and other artisans are not much better off. Socially just forms of bamboo development will be an important aspect of future designs for exploiting the plant. McClure's description of Kang Peng's bamboo job in 1890s China can serve as a sample of what we don't want to perpetuate.

"At thirteen he became apprenticed to a

maker of wooden farm implements. Growing restless before his three-year apprenticeship was up, however, he ran away, taking a job as laborer in a bamboo shop at Wong Lin Hui, Shun Tak, at \$2.00 per year and board. The work was utter drudgery, consisting in part of carrying tremendous loads of bamboo poles from the river where they had been soaking, up through the village to the shop. As they were dripping wet and slimey with mud, he wore no garments except a shoulder pad and an apron of rush matting. People would come to their doorways and watch, amazed at his endurance, pulling down the sleeves of their garments in cold winters to protect their hands from the frostiness of the metal water pipes which they smoked. He was promoted the second year to \$3.00 per year, and during his third and fourth years he received 50 cents per month. From this mere pittance he managed to save always a share to give to his parents."

ble to the common reader, but Beware of Latin Roots if you are not a botanist. McClure himself was an "economic botanist," a student of plants from the perspective of human need. His work was polycultural and interspecific. He was the brief custodian of a vigorously scientific intelligence motivated in choice of subject by a heart friendly and eager to be of true use to his species, which he could see multiplying more rapidly than its ability to feed and shelter the new arrivals.

He was planetary before his culture began to poke its nose out of narrow nationalism, a farmer who knew more than the folks in town about their own interests. He was in love with an order more complex and steady than prosperity—and in 1954 when the USDA cut off support for research that had been ripening for thirty years, his wife, Ruth Drury McClure, already in her sixties, went to work so that he could continue to woo the mysteries of bamboo, a second wife who in fifty years of all three living together, never roused the jealousy of the first.

Among those who worked and lived with him, such as Cleofe Calderon and Thomas Soderstrom, heirs of his work at the Smithsonian in Washington, D.C., he is remembered with a special affection and respect: for his brimming measure of the milk of human kindness; for a warm sense of humor and all-inclusive curiosity; for a modesty as constant as his friendliness; and for a delicate, generous spirit always ready to give and forgive.

FRIENDS OF BAMBOO. From his wife, Ruth, now eighty-five or so, we learned that McClure was, in fact, a "Friend," as the Quakers call themselves. She shares her husband's friendliness—and his love of labor. "I need—I *require* physical activity. If it snows at night, I get up early for fear some neighbor will shovel the sidewalk before me." She lives alone but is much visited in a small house on Quaker Lane in a Friends' "retirement neighborhood" in rural Maryland, woods out her window, a community of people she likes out her door. "Our church is called a Meeting—but the building isn't important. A Meeting can be anywhere, under a tree. The number doesn't matter, either. A Meeting can be two people. A Meeting is measured not by numbers but by openness.

"Quakers are seekers. We're open to anybody. Modest and unself-conscious. Those are the virtues we admire. Mickey was open. He didn't care if it was the janitor or the president. He could sit there and talk to the King of England with no trouble at all . . . We were refugees once, living in Hong Kong. My husband stayed on the campus and was made chief of police. They were bombing Canton everyday. There were nine thousand people on the campus as refugees; 500 acres is a lot to guard. It was the Japanese we were involved with. We had to bow to them every time we went out the gate. They brought big horses with them that ate up all the grass and then got sick. So this Japanese fellow wanted to study the veterinary books at the college.

My husband made friends with him and came home to ask the cook—who was Chinese—if he could bring a Japanese man home for dinner. He turned out to be a good fellow, a schoolteacher. Mickey made friends with everybody, even the enemy."

Surrounded by bamboo artifacts not yet donated to McClure's collection presently housed at the National Arboretum in Washington, D.C., Ruth's memories range from first meeting her husband at Ohio State around 1915 to his last years at the Smithsonian.

Mickey wanted me to help him get his office organized. Everything interested him, so it wasn't easy. And one thing my husband wasn't good at was raising money. When I got down to the Smithsonian, I was ready to cry to see the number of projects he had and no one to help him. And his field work was done under difficulties you can't imagine. He finally used an aluminum-covered notebook. In China he made galvanized sheeting boxes with lids so the stuff could stay dry. You have all these things to carry, and suddenly your carriers run away. From carrying too much himself, he came home once with a bad back that lasted six months.

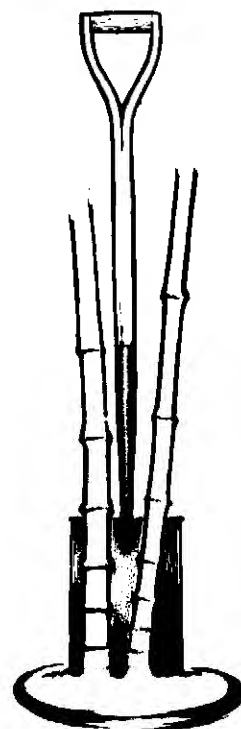
At the Smithsonian, we'd go in at 5 in the morning to avoid traffic, and come home around 3:30. He always brought work with him, but he never did it. He always worked in the garden. We drove home one evening, around cherry blossom time. Mickey said, "Let's go out the George Washington Highway, along the Potomac, and come home the other side." We drove along. I was saying, "In a few days, these buds will be a soft, delicate pink . . ." He said, "I like it just as it is . . ." Later, I said, "Would you like some music on the radio, Mickey?" "No," he said, "I like it just as it is." We got home, it was the first day you could dig in the ground without getting it muddy, so he went out to the garden and came back once to ask how long till supper. About ten minutes later, I went to the window to call him. He was lying down across the sidewalk that goes down to the back gate, with his head pillowed on the grass. I called him, but he didn't move. I knew immediately he was dead. He had his nitroglycerin pills in his hand. A few days later, I went down and saw he had been digging out a rhizome for a child who wanted a bamboo plant. He was digging it out from all four sides of the culm, and the spade was stuck in the fourth side.

FILIAL OBJECTIVES. Three objectives of the compilers of this book are intended as acts of filial piety towards the bamboo student whose scattered notes and articles never vanish for long from these pages.

We intend, with the help of all readers who can relate to these tasks:

1. To make McClure's published works more broadly available in a graphic popular form in a series of publications in both English and Spanish addressed primarily to people who will grow and use bamboo.
2. To care for, propagate, and use (in local crafts, popular architecture, and ecological gardening) the groves he helped establish from Bethesda to Brazil, many of which are in a state of neglect; that is, to realize their dual purpose as garden-schools and gene banks.
3. To extend the cultivation of *Arundinaria amabilis* throughout the temperate regions of the United States where it will survive as a green memory of what the creative industry of one lifetime worker can contribute to the beauty and handiness of a planet more handsome for his brief residence upon it.

"I don't know if you believe in reincarnation—probably you do," she said, eyeing my hair. "But if that's true, I think perhaps he's off somewhere, maybe on another planet, on business I know nothing about. I don't want to be a drag on him, a burden. I want him to be free and fulfill his destiny, in whatever form. But still, I would like to be able



to communicate with him, somehow . . . I talk to him. 'But does he *answer?*' our daughter asks. He doesn't. And I only dream of him four or five times a year. I try to be accepting . . . to *ask* for nothing . . . but sometimes, I say to him, 'You know, Mickey, I would like it if you would come and be with me in a dream tonight—if you could . . .'

Mickey, busy green ghost, by all means feel free to be with your wife in the evenings, but we have a daylight dream as well we'd like you to share, *si Dios quiere*—a reincarnation of your own.

Bamboo classics.

The German botanist, Charles Kunth, was the first to distinguish the bamboos as a separate category of grasses in a paper published in Paris (1815). In 1827 the curator of the Berlin botanical gardens published lists of plants under his care and included descriptions of *B. glaucescens* and *B. arundinacea*. In 1829, Christian Nees von Esenbeck, "a close friend of Goethe and a renowned botanist interested in all branches of natural history, philosophy and social ethics . . . one of the greatest agrostologists of all times,"³ published a masterly treatise on the grasses of Brazil, in which bamboos were included. In 1835, he published the first taxonomic monograph in the world on bamboos, focused exclusively on Brazilian species, dividing the woody bamboos into two main groups, *Bambuseae* and *Arundinariae*. A third group, *Streptochaeteae*, covered the bambusoid grasses, diminutive bamboos found mainly as an understory plant in shady tropical forests between Mexico and Argentina, without economic importance and generally ignored by botanists since Nees.

The Russian Franz Ruprecht, in 1839, published the first monograph on the bamboos, treating them as a subfamily of grasses, dividing the sixty-seven worldwide species into two groups, following Nees, describing only woody bamboos. A distinguished English soldier and botanist, W. Munro, published a monograph in 1868 on world bamboos that divided temperate species into *Arundinariae*, *Arthrostylideae*, and *Chusqueae*, the last two covering New World species. He introduced a new group, the *Bacciferae*, containing eight Asiatic genera, and retained the *Bambuseae* of Nees as well.

S. Kurz, in two lengthy articles published in *The Indian Forester* on "Bamboo and Its Use" (1876), provided the first extended treatment on bamboo in relation to human need in a European language. In 1878 (Paris) the Rivières, father and son, published a tome of 364 pages, *Les Bambous*,

scattered with many beautiful illustrations unsurpassed in any bamboo volume till now. The text is rich in practical gardening experience with many species in their long years of work in Europe and North Africa encompassing both hardy and tropical bamboos.

James Gamble, director of the Imperial Forest School at Dehra Dun, India, published in 1896 an important monograph on Indian bamboos, frequently referred to in subsequent literature. In the same year *The Bamboo Garden* of Freeman-Mitford appeared, the classic Victorian description of hardy ornamental species that could survive in English weather. Ernest Satow's *The Cultivation of Bamboos in Japan*, mainly a translation of a Japanese horticultural work, appeared in 1899, laced with much bamboo lore and graced with a number of lovely watercolor plates. *Les Bambusees* (1913) of Edmund-Gustave Camus was largely a compilation of literature to that time. His daughter, Aimee Camus, in her 1935 *Classification des Bambusees*, published a number of new species and genera from Madagascar and other French colonies.^{3a} F. A. McClure (*The Bamboos: a Fresh Perspective*, 1966) sums up much of the relevant past of bamboo literature in conjunction with his own global experience, and charts the necessary future for bamboo research and development.

CURRENT ASIAN RESEARCH: MODEL FOR WESTERN DEVELOPMENT

A three-day international bamboo meeting in Singapore (May 1980) provides a regional model for the sort of collaboration needed among Western nations with significant bamboo resources. A Canadian report on the gathering is abridged here for its own interest and as sample agenda for Western research.

At least a third of the human race is using bamboo extensively, so "it is remarkable that there has never been in the past an international meeting of research scientists interested in bamboo."⁴ To review existing knowledge, consider problems preventing greater use, and identify regional research needs and priorities, the Singapore workshop was held, partly sponsored by the International Development Research Center (Ottawa, Canada) and the International Union of Forestry Research Organizations (Vienna). Twenty-two participants from the East (Bangladesh, India, Japan, China, Indonesia, Philippines, Sri Lanka, Thailand, and Malaysia) and the West (Canada, England, West Germany, and the Netherlands) surveyed research, distribution,

and use country by country and established future research needs and priorities, such as an international seed exchange to transform flowering of important species from a local economic disaster into an international impetus for more extensive and efficient propagation.⁵

Some conclusions: Taxonomic work in classification and identification is basic to breeding and use. Increasing existing groves is the most effective method for gene conservation, and its importance should be stressed in national parks and other forested areas. Management of sympodial species in India and Bangladesh and the silviculture methods of China and Japan with temperate monopodial bamboos provide models to adopt or adapt elsewhere. Proper grove management includes: *clear* understanding of bamboo's growth; taking advantage of flowering for natural regeneration of groves; increasing yield, fertilization, and pest control studies; encouraging greater bamboo use in erosion control and in rural village economy; developing appropriate technologies in harvest, storage, and transport of culms.

Culm anatomy and the physical, mechanical, and structural properties of bamboos should be more studied, as should relationships between strength and anatomical characteristics. Chemical composition analyses will suggest new potential uses and pharmaceutical possibilities. Fiber studies will improve paper products. Attention should be given to research in natural durability of different species, traditional preservative methods, and design details in construction to maximize bamboo life expectancy in objects and dwellings. Protection by nonchemical methods needs further testing, as do studies on chemical preservatives that are widely available, economically feasible, and environmentally sound. Cheap fire retardants also deserve more study. Improved utilization of bamboo in manufactured products, pulp and paper, and architectural systems is important, and further exploration is needed in plybamboos, hardboards, and particle boards. Use of leftover bamboo stumps and biomass for novelty items deserves investigation, as does energy generation from tremendous harvest wastes: firewood, charcoal and charcoal briquettes, activated carbon, and fertilizer are some possibilities. Studies on bamboo use for human food should be increased and extended to more species. Long-term reinforced concrete research is needed; new processing techniques and machines to increase industrial use are important. Traditional bamboo musical instruments should be publicized

and improved to preserve the heritage of the people and promote commercial development.

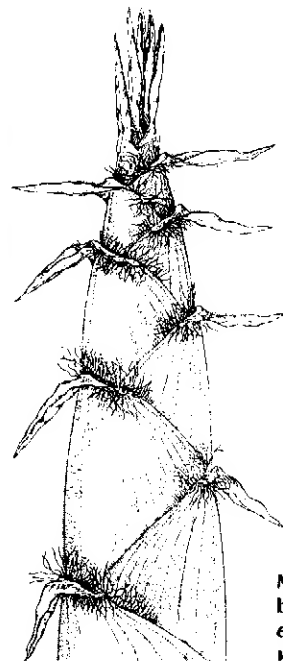
The present high cost of plastics may make possible a strong bamboo comeback if research discovers economic mass production, packaging, and innovative designs cheaper than plastic competitors.

Bangladesh.

The Forest Research Institute (FRI) at Chittagong began intensive bamboo research in 1971, establishing twenty-four species at the FRI Arboretum and four field stations, two in the northern deciduous forests where only cultivated groves are found and two in semievergreen regions in the southeast where spontaneous natural groves occur. Studies of flowering, seed longevity and storage, propagation, and pulping qualities of different species are among works in progress. One research focus is tissue culture propagation. Study has found that only buds are suitable for tissue culture. Bamboo culm buds are all multiprimordial, each primordium consisting of a rhizomelike structure. Entire primordial structures are used in tissue culture trials. Species, distribution, total acreage of groves, annual yield, and value of bamboo products are not reported.⁶

China.

With 2.9 million ha in twenty-two provinces from sea level to 3,000 m, China has nearly twenty-five



Moso (*Phyllostachys pubescens*) provides the largest part of the oriental harvest of edible shoots.

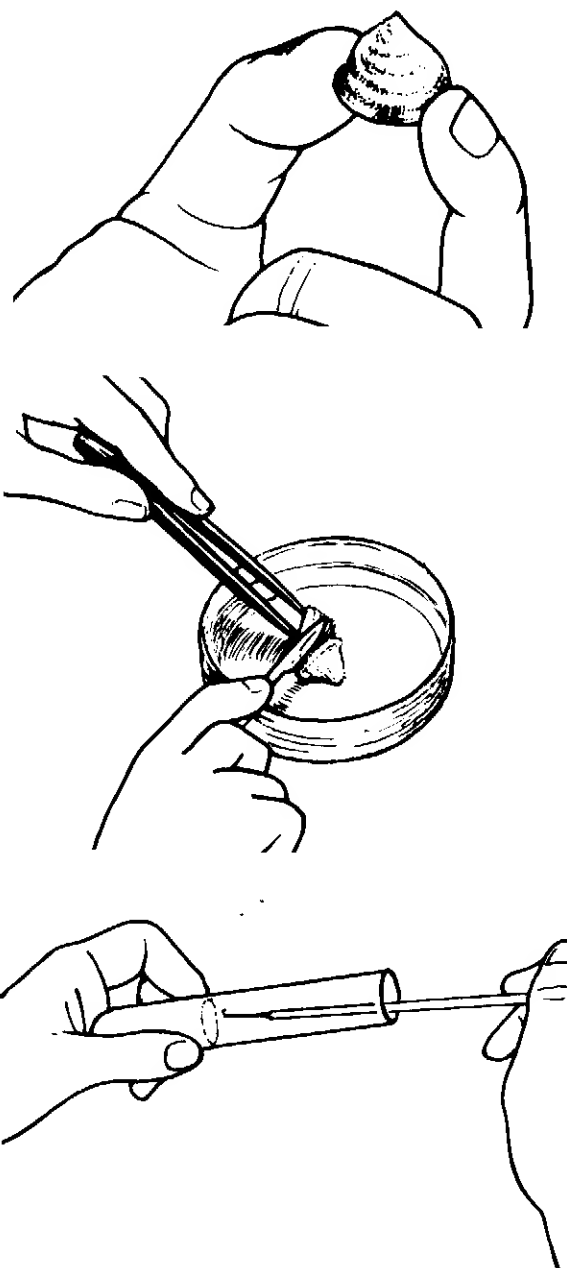
times the bamboo reserves of Japan—and one third of India's (1 hectare = 2.47 acres). Two million ha are devoted to *Phyllostachys pubescens*, scattered in twenty-three production bases and introduced in 230 counties. Of 300 species in twenty-six genera in China, 200 bamboos from twenty-two genera are of commercial importance. Bamboo plantations form part of China's reforestation plans, the most effective in the world. In the Yellow River valley, for example, groves of *P. glauca*, *P. bambusoides*, and other bamboos now cover 30,000 ha—four times their former extent. High-yield tactics such as selective cutting to maintain grove nourishment, fertilizing, loosening soil, weeding, and rational harvests have also increased size and weight of individual culms.

Bamboo research departments have been established in the Chinese Academy of Forestry Services and related forestry colleges, as well as in provinces intensely cultivating *P. pubescens*. Bamboo hybrids have been realized at the Hunan Botanical Garden and the Guangdong Provincial Research Institute of Forestry. Recent anatomy and physical and chemical property studies now permit identification of bamboo fragments found in archeological excavations of sites seven thousand years old. Biological pest control is another research priority: There are 100 anti-bamboo bugs in China, and large-scale plantations invite large-scale problems. In the early 1960s, stag-head disease damaged 700,000 ha of *P. pubescens*, and in 1975 an equal area in the same province (Zhejiang) was infested by *Algedonia coclesalis*. Some nine million culms were lost in the two plagues.⁷ (See also "Green China," pp. 288–290.)

India.

Twenty genera, 113 species, cover 9.57 million ha, 12.8 percent of India's total forest area, from sea level to 3,700 m in the Himalayas. Only 10 species are commercially exploited on a significant scale, with present estimated annual revenue from bamboo at approximately \$8.53 million (U.S.), less than \$1 per ha, which gives some notion of the underexploitation of bamboo resources. The extensive research of the Forest Research Institute and Colleges, Dehra Dun, has been treated in scattered portions of this book. Research with *D. strictus* over the years provides a valuable model for similar depth studies of other bamboos elsewhere.⁸

RESEARCH PRIORITIES. "For genetic upgrading of bamboos, a virgin field, the Forest Research Insti-



Tissue culture. (A) The tip of a bamboo shoot provides meristematic tissue—cells capable of division—that can produce, in a nurturing medium, thousands of times more propagules than conventional means. (B) A minute piece is severed from the tip—a microchip containing all the data and chemical codes needed to make this species, complete with its special stripes on leaves or unique air canals in rhizomes. (C) A grove that

can arrest erosion on a hillside while providing the raw material for a village industry begins with a speck. Tissue culture, realized in other plants, is still in its infancy with bamboo, but appears to be the relevant route to global sufficiency of elite bamboos. Miniaturization, seen by Fuller and others as the thrust of all technology, finds its present expression in bamboo cultivation in tissue culture of the plant.

tute proposes three field stations in East, North, and South India for temperate, subtropical, and tropical species, with headquarters at Dehra Dun, to collect bamboo germ plasm from roughly one hundred wild Indian species, for growth in gene banks for evaluation and research. Genetic improvement of some ten top commercial species will be given high priority. Selected stands in certain areas will be conserved.

"Work will include surveying major bamboo areas, studying for genetic diversity, selecting suitable clones for conservation; collecting material for taxonomic, cytologic and palynologic studies; adding to banks variants arising as bud-sports; establishing one-parent progeny trials from seeds of species that may occasionally come into flower, evaluating progeny, selecting desirable seedlings and cloning for use in clonal trials which will also throw light on the breeding system of the species; exploratory hybridization using commercially important species of *Bambusa* with *B. atra* (a constant-flowering bamboo), species of *Arundinaria* with *Indocalamus wightianus*, an annual-flowering species, and so forth, studying the interspecific hybrids that may be realized.

"Nonavailability of seeds and transport of bulky propagules suggest the technique of tissue culture and/or shoot culture in bamboos to make the exchange and establishment of germ plasm much easier. This research should be given high priority, as well as the flowering mechanism in bamboos—one of the greatest botanical mysteries. Control over flowering would provide material to taxonomists to determine generic affinities of various species, to breeders for controlled hybridization and progeny testing. This feat could serve the cause of both applied and fundamental science."⁹

Indonesia.

Bamboo is in daily use by the people, and employment has "extended remarkably in the last few years." Industrial demand is also large, but researchers ignore bamboo, and forestry personnel turn groves into pine plantations. There is no full-fledged Indonesian expert on the biology or technology of bamboos. Many bamboo objects have been made obsolete by modern technology so the Lembaga Biologi Nasional (National Biologic Institute) in Bogor initiated emergency ethnobotany bamboo studies in 1975, focusing on musical instruments, fishing equipment, and wickerwork—particularly carrying baskets. A research priority is the role of bamboo in traditional Javanese customs.

The increased use of bamboo in landscaping is under evaluation by students of the School of Garden Architecture at the University of Trissakti, Jakarta.

Use of bamboo for lightweight harvesting poles has resulted in plans for large-scale plantings of *M. baccifera* in oil palm areas of Sumatra. Construction remains the most extensive popular use: in Central Celebes split bamboo is used for roof tiles. Scaffolding, bridges, smokehouses for tobacco, and furniture are common bamboo uses, and tribes weave mats, baskets, and so on in distinctive patterns. Toys, vases, carvings, and a thousand bric-a-brac are produced, and *Tangerang* hats have become world famous. *G. apus* is much used, especially in West Java, for string. Waste branches provide valued firewood in some areas.

During the war for independence, a sharpened bamboo spear became a well-known weapon with "a respectable place in modern Indonesian history." There is an ample traditional arsenal of bamboo weapons, and bamboo arrows are still used in West New Guinea. For centuries of Indonesians, bamboo was the first piece of earth to touch them on entry: A freshly split bamboo knife severed the umbilical cord, and males were circumcised with the same sharp instant instrument.

West Java musical instruments depend on *G. atter* (*bambu hitam*), and only plants of this species grown in West Java are of the right quality and dimensions. Recently developed furniture and village handcraft industries, with enormous capital compared to instrument makers, are using this species and thus edging out the home-industry-scale instrument artisans. People have no extensive traditions of growing bamboo, so regeneration is left to nature—adequate only to earlier population densities and use. Quantities consumed in furniture are also a factor. A table and four chairs will use as much bamboo as an entire orchestra of instruments.¹⁰

Japan.

Makino, Tsuboi, and Muroi are among the early twentieth century bamboo students who laid the basis for the complex taxonomy of some 669 species in 13 genera which are native to Japan. Only a few are important in the national economy. Madake (*Phyllostachys bambusoides*) and moso (*P. pubescens*) make up 84 percent of Japan's 123,000 hectares of bamboo groves, and *Arundinaria simonii* provides some 7–8 percent of the harvest. Studies on pest control in living groves and preservation of harvested culms has intensified

since the 1960s. Harvest season greatly influences susceptibility to attack; late fall is best, April-June the worst time for cutting in the Japanese climate. Anatomical studies have disclosed characteristic culms for each species in terms of length, wall thickness, and in length, diameter, and number of internodes.

A paper mill was shut down in the 1960s, but research continues. An ancient technique using wood ash at ambient temperatures to defibrate young culms has been studied. A hand operated paper maker used by villagers combines bamboo pulp with other fibers successfully, and the institute of papermaking in Kochi Prefecture is researching small-scale paper production from waste of basketry and other uses. Japanese research is extensive and active. Lessard (1980:47-56) provides a scan of it which is suggestive for any country wishing to expand its bamboo research and development.

Malaysia.

Forestry services regard bamboos as weeds interfering with timber. Bamboo use is widespread but primarily small scale and cut from natural stands; cultivation is seldom practiced. Low durability is a problem. Incense sticks for Chinese religious rites are an important small industry, with 1978 exports valued at \$654,080 (U.S.). The industrial sector is interested in canning shoots and producing lightweight bamboo harvesting poles for oil palms. A recently formed committee to coordinate research has priorities of performing taxonomic and ethnobotanic research; establishing a living collection for research, teaching, and gene conservation; and preparing an identification guide to forty-four regional species in seven genera.¹¹

Philippines.

Of fifty-four species in ten genera, eight are commercially important: *B. blumeana*, *B. vulgaris*; *D. latiflorus*, *D. merrillianus*; *S. lima*, *S. lumampao*; *G. aspera*, and *G. levis*. From 200,000 ha mentioned by Gamble in 1910, bamboo areas dropped to 7,924 ha in 1978, or .03 percent of total land. It is not said whether private groves figure in this total. A research gap from 1930 to 1957 followed some earlier work, but revived interest since the late 1950s still leaves much unknown: distribution, yield, current and future needs of bamboo industries—all require more study. No Filipino taxonomist is involved with studies of Philippine bamboos. Harvests are not cut in a technically qualified manner. Rice, corn, sugar cane, and coconuts have

edged out extensive nineteenth century bamboo plantations. Spontaneous forests are found in all parts of the Philippines but are not large and are diminishing from fires, grazing, and overcutting. There is probably more cultivated than spontaneous growth at present. Yield figures indicate the following culms per hectare: *B. blumeana*, 7,000-8,000; *B. vulgaris*, 9,000-10,000; *S. lumampao*, 9,000-10,000. Sawale, an important woven wall matting, is made from *S. lumampao*. One introduced species of *Phyllostachys*—*nigra*, var. *henonis*—grows well in the Philippines. Study center: Forest Research Institute, College, Laguna.¹²

Sri Lanka.

Fourteen species have been listed for the country, five widely used: *B. orientalis*, *B. vulgaris*, *B. vulgaris*, var. *vitata*, *D. giganteus*, and *O. stridula*. Bamboo has never been cultivated systematically, and there has hardly been any research on propagation or utilization. "In view of the importance of bamboo in the local economy, bamboo silviculture should be given more future importance . . . demand will soon outstrip supply. . . . The Forest Department is now contemplating the planting of bamboos." Report from Research Division, Forest Department, Colombo.¹³

Taiwan.

Export of bamboo shoots and some twenty-five bamboo products has been increasing steadily since 1960-61. With 1963 as a base year, the 1972 index on the export value of bamboo shoots stood at 503, poles and processed products at 1,218. Shoots are canned, preserved dry, boiled, salted, dehydrated, and shipped fresh. Development of new products include bamboo veneer, in 5-meter lengths (16.6 feet), thickness of 0.5 mm (.02 inch), used for plybamboo, trays, paneling and so forth. New processes include a dark brown coloring treatment for bamboo splits or veneers placed in 160°C kilns at 4 kg/cm² for 30-60 minutes. Hog pens, mushroom culture houses, oyster stakes, and banana supports are some of the main agricultural uses of bamboo, domestically.

Computerized yield studies estimate 21.06 metric tons of green, 15.35 metric tons of air-dried poles per hectare for a *makino* bamboo grove (*P. makioni*) with 9 m (30 feet) average height, an average density of three poles per square meter.

Among fifty-four reported species, the chief used are *P. makioni*, *P. edulis*, *D. latiflorus*, *B. oldhami*, *B. stenostachys*, and *B. dolichoclada*. Stud-

ies on genetic variability of Taiwan's 80,000 hectares of *D. latiflorus* and a selective breeding program for locating high-yield bamboo shoot clones have been initiated, using techniques of zymography. Analysis of peroxidase isozymes and microscopic study of leaf bristles and stomata reveal highly concentrated genetic variability in the west central part of Taiwan for this important species cultivated for both shoots and poles.¹⁴

Thailand.

About 2.5 million acres produce an annual harvest of some 600 million culms. Of the forty-one species in twelve genera reported, *T. siamensis*, 1.1 million acres (450,000 ha), and *B. arundinacea*, 625,000 acres (250,000 ha), are the most common, the first yielding 2,500–3,000 culms, 22–37 tons per acre (8.8–14.9 ton per hectare) annually; the second, around 62 tons per acre (24.7 tons per hectare). Groves are found in teak forests in the north, in evergreen or mixed deciduous forests in the south. Other important species include: *Bambusa blumeana*, *nana*, *polymorpha*, *tulda*, *vulgaris*; *Dendrocalamus asper*, *brandisi*, *hamiltonii*, *longispatus*, *membranaceus*, *strictus*; *Cephalostachyum pergracile*, *virgatum*; *Gigantochloa albociliata*, *nigrociliata*, *hasskarliana*, *macrostachys*; *Thyrsostachys oliveri*. Thai people eat a lot of bamboo, so much so that shoots taken from natural forests are a main source of depletion. Study center: Bamboo Research Station, Kanchanaburi Province, southwest Thailand.¹⁵

Fishing rods of *Thyrsostachys siamensis* are a large export item, and export of *D. asper* shoots have a "great future."¹⁶ For recent work with bamboo cement, see "water storage" (pp. 66–67).

RESEARCH CENTERS AND GROVES: A SCANT SAMPLING

Note: Ministries of agriculture, forestry, and housing; botany and architecture departments of universities; arboretums and botanical gardens are all good places to start looking for active students of bamboo in any country. Other centers can be found, by country, in the reports above.

Centers.

FAR EAST.

Forest Research Institute
P.O. New Forest
Dehra Dun, India

Forest Research Institute
Chittagong, Bangladesh

Forestry Division
Joint Commission on Rural Reconstruction
37 Nan Hai Road
Taipei, Taiwan

Department of Forestry
Kyoto University
Kyoto, Japan

Department of Agriculture and Natural Resources
Manila, Philippines

National Forestry Research Bureau
Nanking, China

WEST EUROPE.

Tropical Products Institute
56–62 Gray's Inn Road
London, WC 1, England

LATIN AMERICA.

Instituto Nacional de Investigadores Forestales
Mexico, D.F.

Centro de Investigacion del Bambú (CIBAM)
Facultad de Artes, Universidad Nacional
Ciudad Universitaria, Apartado Aereo 54118
Bogotá, Colombia (*Oscar Hidalgo*)

UNITED STATES.

Division of Plant Exploration and Introduction
Bureau of Plant Industry
Washington, D.C.

Department of Botany
Smithsonian Institution
Washington, D.C. 20560
Main bamboo library in the West.

Groves.

UNITED STATES.

USDA Plant Introduction Station
Savannah, GA 31405
(*Nine miles south of Savannah on Ogeechee Road.*)

George Darrow Groves
5900 Bell Station Road
Glenn Dale, MD 20769

Jungle Gardens
Avery Island, Louisiana
(*McIlhenny's Groves, begun in 1910. In mid 1940s, sixty-four species covered 80 acres.*)

Arboretum
Golden Gate Park
San Francisco, California

Quail Botanical Gardens
230 Quail Gardens Drive
Encinitas, CA 92024
(*American Bamboo Society Collection of some fifty-eight species, not all at the ¾ acre site at Quail.*) (Cf. *Journal ABS* 1.1:16-8.)

Green Gulch Zen Center
Rt. 1
Mill Valley, CA 94965

CHINA.

Lingnan University, Canton
(600 species; begun by McClure c. 1924.)

JAPAN.

Fuji Bamboo Garden
Nagahara, Gotemba
Shizuoka Prefecture, Japan

ENGLAND.

Pitt White Bamboo Gardens
Uplyme, East Devon, England (*southwest England*)

LATIN AMERICA.

Federal Agricultural Experiment Station
Mayaguez, Puerto Rico
(USDA)

Suchetepequez, Guatemala

Santa Ana, El Salvador

Lancetilla, Honduras

El Recreo, Nicaragua

Turrialba, Costa Rica

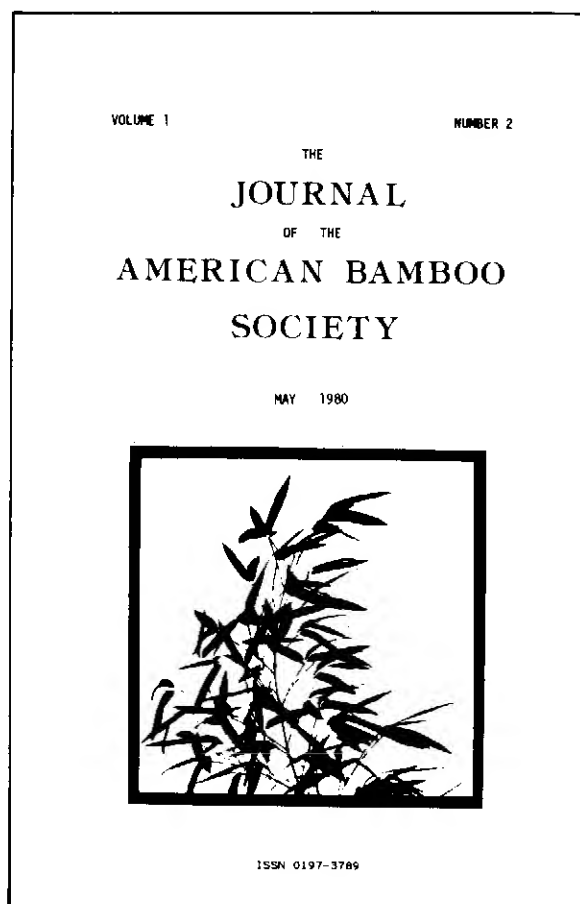
Summit Gardens, Canal Zone, Panama

Pichilingüe, Ecuador

Escuela Experimental de la Molina, Lima, Peru

The American Bamboo Society.

The American Bamboo Society was formed in 1979, in California, "to fill a vacuum in bamboo culture and research that has existed since the USDA stopped large-scale bamboo research in 1965. Following the examples of the Lingnan University bamboo collection in Canton [begun by McClure in the 1920s] and the Fuji Bamboo Garden in Japan . . . the primary objectives are (1) To provide information on identification, propagation, and utilization of bamboos through a journal, library, and herbarium. (2) To promote use of elite species through distribution of plants to botanic gardens



and eventually the general public. (3) To preserve and increase the number of bamboo species in the United States, establishing a bamboo quarantine greenhouse in the San Diego area to import selected species from foreign sources. (4) To maintain a bamboo garden to display beauty of mature plants and provide a means for research in the culture of as large a number of species as possible."¹⁷

Quarantine.

Early twentieth century bamboo plants from the Orient carried bamboo pests with them (see pp. 225-226, pests, smuts, and rusts). All bamboo plant introduction has, in consequence, been regulated strictly by the USDA since 1918: "The importation for any purpose of any variety of bamboo seed, plants, or cuttings thereof capable of propagation . . . is prohibited, except for experimental or scientific purposes by the Department of Agriculture."¹⁸ Permission to import bamboo can be obtained, however, by groups responsibly following government quarantine regulations, such as the American Bamboo Society.

The *Journal* of the American Bamboo Society

(1.1:2-11) provides a useful survey of USDA introductions from 1898-1975. Some 189 identified species and variants are included, together with a large number of introductions in which only the genus is named.

Experimental bamboo farm.

Bamboo gardens are important for the spread of bamboo plants and information, but something in the very size of bamboo clamors for a bamboo farm. Apart from large urban parks, there are few areas in cities with enough space to establish large-scale plantings together with the curing sheds, preservative rooms, workshops, and toolsheds that are required in growing, processing, and using bamboo.

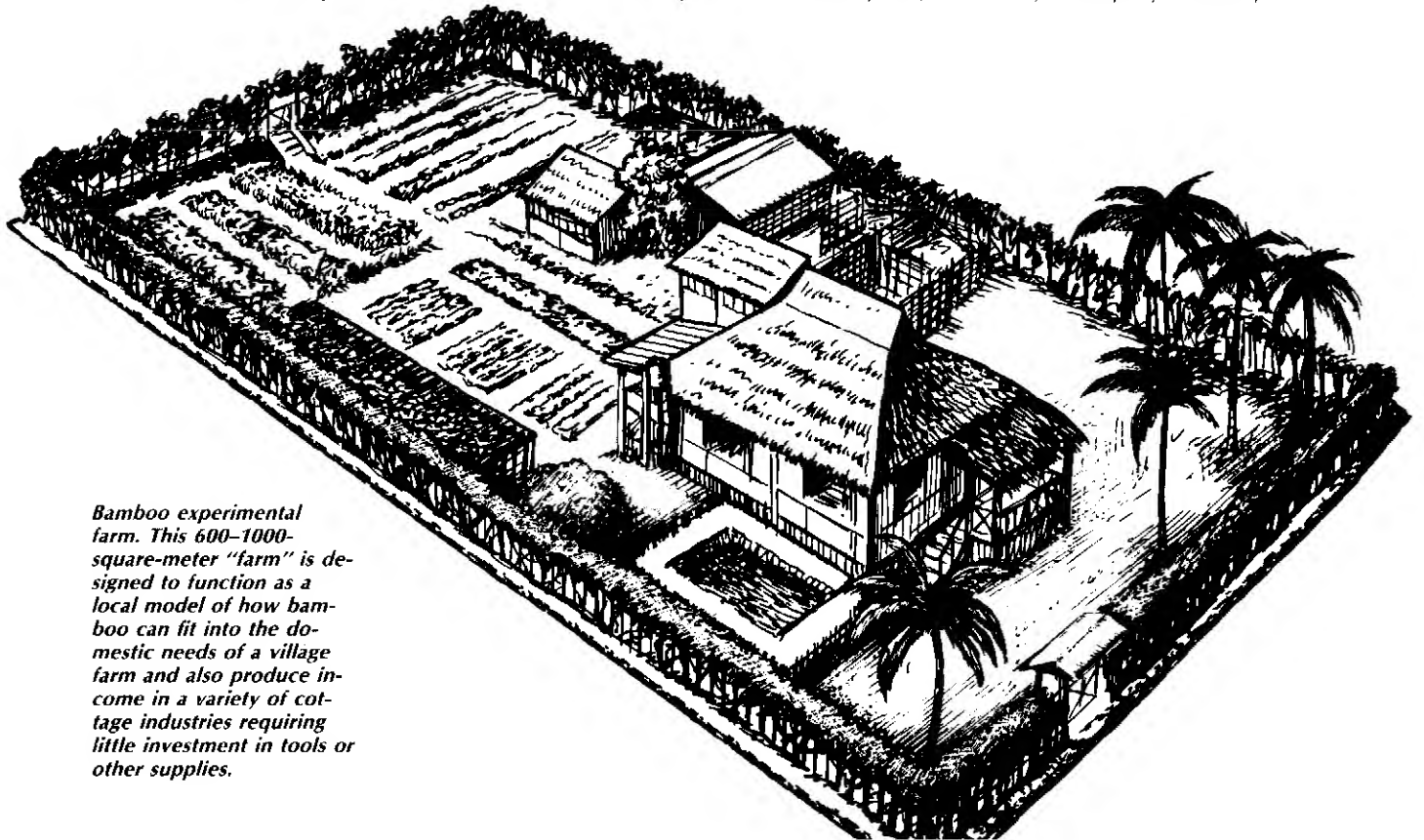
Granted the desire to extend the awareness of bamboo technology, a bamboo farm should include, as well, facilities for prolonged visits from those who would like to learn its large-scale management. The lack of such training facilities open to the public has resulted in the neglect of most ambitious plantings of bamboo in the West. Training bamboo cultivators, builders, inventors, artisans, salespeople, manufacturers, and messengers must be a priority of any bamboo enterprise that hopes to survive the enthusiasm of its initiators. All these roles are required for large-scale commercial production of bamboo plants, lumber, and artifacts.

Generations of bamboo proponents have come and gone in the United States and the West, and many of the groves they established have been destroyed or have fallen into complete neglect or underproduction for lack of young hands and minds to follow the old man's affection for the plant. Where they still exist, they are the natural location in their region for a farm-training bamboo village.

A bamboo farm, by the nature of the plant, calls for a design quite different from a farm focused on wheat, corn, soybeans, or some other staple crop already well established in the agricultural economy of the West. The broad uses of the plant, still so scantily known among us, require a location where its versatility can be demonstrated. Bamboo's retarded cultural role implies a farm more experimental in nature than farming almost any other crop imaginable, with far more conscious public relations and public play than, say, a hog farm in the corn belt.

WHOO'S WHOO: BAMBOO GREEN PAGES

The World Directory of Bamboo Researchers lists 203 students of bamboo from twenty-four countries: Japan (54), the Philippines (31), India (24), Taiwan (22), Korea (15), Thailand (13), the United States (9), England (6), Bangladesh (5), China (4), West Germany (3), Australia, Malaysia, Mexico,



Bamboo experimental farm. This 600-1000-square-meter "farm" is designed to function as a local model of how bamboo can fit into the domestic needs of a village farm and also produce income in a variety of cottage industries requiring little investment in tools or other supplies.

Nepal (2 each), Brazil, Burma, Canada, Chile, Colombia, France, New Zealand, South Africa, and West Samoa (1 each). The number from Japan reflects a pardonable regional bias, natural for a Japanese editor for an event in Japan. The few names from mainland China indicate an unfortunate information gap. But the twenty-nine pages of bamboo students is a welcome start in the necessary direction of networking the planetary students of the plant.¹⁹

Obviously not every bamboo student in the world is in this directory. Still their numbers in relation to the population at large are few. How many doctors, lawyers, etcetera, whatever have you met? How many students of bamboo have you stumbled across? Even in countries where bamboo is economically important, bamboo researchers are the eye of the needle in the haystack. Lessard (1980) lists some twenty who would be valuable leads in many countries East and West. The *Journal of the American Bamboo Society* provides contact with its members. Bamboo flute people's addresses are available through Shepard and Levenson. (See also: *Take-no-Michi: A Newsletter of Shakuhachi and Related Arts*, published by Barry Weiss, 419 4th St., Brooklyn, NY 11215.)

The *World Directory* lists researchers by area of concern, such as distribution, ecological studies, cultivation (propagation, plantation methods, optimum felling cycles), harvest and transportation systems, anatomy, physical and chemical property studies, biochemical and biophysical aspects of bamboo formation, seasoning and preservation, pulp making, mechanization for processing in local industries for food, handicrafts, furniture, building materials, and bamboo-based panels.

From the listed categories, from published books and articles, and from experience of the Western bamboo community from the U.S. to Peru, it is apparent that bamboo is a circus with many rings but no barker. There are no bamboo communications specialists evolving tactics for increasing awareness of the plant on the part of governments and peoples. Oscar Hidalgo, in Colombia, is a rare exception to prove the rule. An architect, a teacher at the national university in Bogotá, he has managed time for three books (1974, 1978, 1981), and a film on a shoestring budget (1981). Parts of the filmscript are found in Chapter 5, pp. 122–123. He has conducted prolonged bamboo agitation among a broad circle of friends from many nations and supervised or inspired a number of projects that have made him *Papa Bambú* to many in Latin

America. He works with an infectious warmth and enthusiasm, animated by a constant human interest in bamboo use among the poorest people. "Oscar is 200 percent crazy," an agronomist told us in Colombia. "Too bad there aren't many more with his madness."

The need to network: *Bamboo Tube*.

Apart from Hidalgo and his welcome ilk, elsewhere by whatever grove, many more scientists are fretting full time over their piece of the bamboo puzzle than are coordinating the vast masses of bamboo data, extracting a relevant vision of development design and communicating it in a way that can be heard by the masses whom all this research is ultimately meant to serve. A great gulf is fixed between the expert in the lab and the *campesino* in the field that somehow must be bridged for bamboo to assume its deserved prominence in the cultures and economies of the world's peoples.

Bamboo messengers are needed, as is a place and method to train them, and a publication to share relevant experience with the larger world. Those wishing to participate in the creation of such a center or centers in the West can communicate. Minimally, as an update some two years after publication, we intend mailing an irregular newsletter, whose first objective will be to make available, by name, address, and phone if desired, a list of those concerned with bamboo development in the West and caring to share their concern with others. Excerpts of bamboo information provided by correspondents will hopefully find room for inclusion. Send to *Bamboo*, Box 666, Bolinas, CA 94924.

MESSAGE DESIGN

This is not a book.

This artifact is composed of equal parts sweat and affection, collaged almost completely of recycled, even ancient, thoughts perched for the moment in English but ready as a resting wren to reenter the common air that bathes the globe. It has no chemical additives, is not toilet-trained, tamed, shaved, or built for sale. That those who need it most will sell hours of a brief life to buy it and read it is a chief defect of its design. It will knock down trees for pulp, and the nests in them, consume limited fossil fuels in its distribution. Some copies will be given to seduce the wrong lover or bought and given for Christmas to the wrong aunt, to lie silent seventeen years on a shelf and then burn to ash in a fire. Others will pass the hours of commuters, insomniacs, and other compulsive readers. One copy—

it could be the one in your hands—will meet the proper person at the proper time, infect a life with a life errand, repay the labor of compiling it, and compensate for the waste of ten thousand copies that do not reach their intended objective of a destined eye.

At a 1965 exhibition of Magritte in Chicago, a woman stopped with her husband next to a painting, squinted at the title, and read in midwestern French, "‘*Ceci n’est pas une pipe. . .*’ But it *is* a pipe!" And furthermore, Madame, this is not a book. A normal book is happy in a bookcase, but the very ink of these words aches to run over the margins into the world.

A quilt of quotes.

This work is in large measure a quilt of quotes. We have attempted an organic anthology drawn from bamboo literature that is rarely available even in the best libraries. A dialogue of many voices is always more useful than a monologue if the voices chosen are articulate. But this method implies much editing to make the pieces fit, filling gaps and pruning overlaps. We have made a virtue of the editing that necessity imposed. In addition to eliminating repetition from selected quotes, we condensed them to their core line of argument or information, rigorously pruning, always remembering Jack Sprat, who ate no fat, and Nietzsche, who hoped to say in a sentence what others said in a book.

We have inserted striking phrases or facts from the quoted author’s own total work if it served to heighten the intensity, relevance, or eloquence of the cited observation. We have striven to preserve style as well as sense. For readability, we have eliminated the dots, brackets for minor supplied words, and other conventions of typography and scholarship. Our intent has not been—ever—to betray the original but to intensify the information per inch throughout a treatise whose amplitude demands economy of expression.

In the case of material from general literary sources and a range of contemporary culture, these nonbamboo books are provided as samplings of the directions bamboo development studies must take. The more subtle the grafting of any new crop or cultural innovation, the more chances for successful new life. These quotations—on shelter, education, and the whole spectrum of human values—are intended as a chorus of elders of the Global Village, which looks over our shoulders bent above this prolonged task. "The World wrote them, Goethe signed them," one author said of his work. Our

intention has been to present the human reality of our time, in its roots and in its urgency, through the most complete voices of those who cared most deeply about the design choices confronting their species in its cultures and agricultures.

For lack of space, many remain unquoted, or barely mentioned, who are in fact the invisible underpinning of this work and who describe its desired future trajectory—they are usually noted and starred in the bibliography. Alexander, Illich, Kern, Montessori, Mollison, Prest—these are among them. Others, like Darrow, are sufficiently visible in a scan of footnotes to indicate our debt.

Fracture survival.

Survival in fragmented times is always precarious because survival is wholistic. But the judo of nature makes use of fracture in interesting ways, transforming breakdown into a technique of survival. Grab a lizard’s tail, and you find he is equipped to leave it squirming in your hand as he returns to his family. Pieces of an artwork could imitate this design wisdom and, if possible, even improve it, leaving a tiny wriggly lizard living in the palm of your mind. Many pieces of this book are intended to form small wholes whose sense survives surgery from the surrounding animal. They can be broken off easily and used in many contexts with no direct relation to bamboo. The Eastern respect and feeling that surround bamboo can find Western expression in many forms with no physical presence of the plant. Bamboo is not the only ally on the path towards bamboo attitudes. (See, for example, *Earth Basketry*, Tod 1972.)

Radio rapidea.

Books should be designed to fit easily into radio. For thousands of millennia before written or printed words, there were spoken words. Books come long before radio in the chronology of invention, but what they deliver is more "modern"—the written word. Radio brings the ancient human voice to the ancient human ear. Present-day books should acknowledge radio as an ally by presenting information in a way that feels fluid on the tongue, with all the vigor and verve of speech. Information bits should be brief and form complete wholes in themselves, as well as portions of a larger whole.

A series of five-minute radio talks on bamboo is available in English and Spanish from the author on request. Twenty segments on a single cassette are designed for a four-week series but can be combined to form longer portions of a shorter run. Bam-

boo music, flute and percussion, provides a recurrent motif. Radio provides more broad and rapid idea diffusion than print and is particularly suited for village areas where bamboo is most relevant and books least used. The terrains for bamboo development imply both Spanish and English versions. Unfortunately, no such series is available elsewhere for the 800 million or so planet residents who listen to these two tongues, culturally and geographically densely related, which dominate the West: *Ingles-pañol*.

Explanations are bad Zen.

*He was the Village Explainer,
excellent if you were a village;
if not, not.*

—Gertrude Stein, of Ezra Pound

Until now, we have more or less assumed the semitidious role of Village Explainer, spelling it out as plain as possible: long lists of Latin names and so on, a superbores if you don't first feel the total bamboo conception. As this book moves to a close, we have resorted more to hint, hymn, fairy tale therapy, fragments of old masters, the shaggy, uncombed eyebrows of oracles to say it. Explanations are bad zen; they will die on the road home to our reknowable energy. Overtell yields underlisten. Lakes rest in the shape of land under them. Design the message by the ear.

Bamboo Ring

*Once upon a tale, there was a morning
that round a wandering shoulder wrapped a
road.
A bend of it revealed, requesting kisses,
a double ugly but seductive toad.*

*Which done, she hopped before him to a
village,
and taught en route a simple song to sing
that turned the toad into a shining maiden,
and in her hand, a tiny bamboo ring.*

*All who tried it on went mildly crazy,
and felt a funny hum until they died;
the busy took the time to aid the lazy,
the friendly kept the lonely by their side.*

*Elites of greed began to feed the others.
Soldiers dropped the gun and hugged the foe.
Strangers treated strangers like their brothers—
but that was long away and far ago.*

MESSENGER DESIGN: TACTICAL ATTITUDES

*The point isn't merely to understand
history, but to enter and change it.*

—Karl Marx

*If you fall into a pit
and three uninvited guests
land later on top of you,
welcome them cheerfully.*

—I Ching

Acupuncture is the art of effecting maximal positive reaction through minimal pressure, perfectly placed. The cultural equivalent of this economy of means is the study of all those who are poor or few in relation to the dimension of a prevailing error, but who, nevertheless, refuse to remain its victim.

Traditional oriental hints on the art of cultural acupuncture are densely embedded in a long literature on the Art of War, classically defined by Sun Tzu (c. 400 B.C.) and crowned by Miyamoto Musashi (1584–1645); and in a long scrutiny of tactical attitudes for students of personal or cultural change, in such summations of Eastern philosophy as the *I Ching*. Somewhat in the spirit of "flying white" brush strokes of *sumi-e* painting, we offer the barest suggestion of this rich heritage.

Learning to meet: the I Ching.

*The bird, a nest.
The spider, a web.
The people, friendship.*

—William Blake

*Life winds a lot.
Sometimes it's easy,
sometimes it's not.
Sometimes you talk about it,
sometimes you can't.
But when two friends share one inside,
their hearts are just there,
like weather or air,
and their words smell like flowers.*

—Confucius

The Chinese are the most numerous people on earth with the longest surviving cultural attic. They have the world's most extensive archives on the art of meeting and the most ample ongoing laboratory to explore human relationships: one billion people means many meetings. Since their culture has proved so durable, their earliest conclusions on the methods for durable and meaningful meeting deserve pondering. "Friendship" is our word for com-

The invention of the eight trigrams of the I Ching is attributed to the legendary Emperor Fu Hsi (2900 B.C.). The straight (yang) and open (yin) lines which form the trigrams are stylized genitals. The unbroken and broken lines also suggest the erect stalk and emptiness, or node and internode, of bamboo, which serve to sum up the basic rhythm of life.



plete meeting. We are friends in direct proportion to our capacity to meet the entirety of the other with the entirety of ourselves. Remaining friends is an art even more rare than becoming them, because friendships also, like all mortal things, are buffeted by Change, the main and most mutant divinity in China's ample pantheon. Change being the essence of life, learning to meet Change, becoming optimal mutants, the friend of Change rather than the victim, became the essence of learning for the Chinese.

Hard to start? Invite helpers—but don't doze on their shoulders. Keep changing in the midst of danger: that's how complete people draw order from confusion, like thunder wringing rain from clouds.

They especially studied mood changes, rapid shifts in emotions, the inward weather of human nature, observable, with training, at first feel in ourselves and at second hand in the behavior of others.

Temper pop in the family, friends look like muddy pigs or a carful of hoods—but ugly's in the mind of the beholder. Friendship heals feuds, links families. Tight spots mean more room for friends; more friends mean more forgiveness.

Forgive is lighter than grudge. First crying, then laughing. After fighting like crazy, we get sane and meet.

Friendship, the perfect meshing of weathers, was in some ways their ultimate art form, a process of mutual transformation. Friendship is an alchemy in which both lead and laboratory are another alchemist. It is the most subtle instrument or condition for one's personal growth available, an effective device of our emotions, rapid and sly beyond any art or science to arouse our slumbering faculties to their most flourishing development.

The more psychiatrists and "mental health personnel" multiply among us, the more we announce the erosion of friendship in our culture. The need for such doctoring is rare if the heart and ear of an alert friend are available. The most mentally healthy culture, in fact, will be that which most fosters friendship in home, school, market—the whole fabric of a culture is based on the experience of friendship, because without this intimate and personal school of union it is doubtful that more impersonal or abstract cultural unities like towns and countries can have much human vitality. Friendship is even more basic than the life, liberty, and quest for happiness declared by Jefferson as fundamental rights

of a democratic society, because even death or any lesser oppression can be tolerable in the embrace of friendship, but a life or liberty or happiness without it is something not only "less than human," but less than animal or plant: friendship is inherent to all natural forms of life. It is distinguished from many human art forms in that, like true ritual or a sense of "ceremony," it can exist in the leanest times, with minimal economic base.

The lotus blooms in muddy water. In danger,
deep holes, thorns, three years of wall and
knotted rope, live simple and forego decor. Broke
is beautiful: a bowl of rice, a jug of wine—two
small flowers are enough for the ceremony.

—*I Ching*.

When the people of China called bamboo the Friend, it was no mean complement. Out of a bewildering abundance of species that botanists have declared the broadest repository of flora in the world, they considered three plants Friend: the pine, the plum, and the bamboo. If you act on this hint and actually regard bamboos not only as persons, but as friends energetically devoted to your interests and responding to your attentive affection, a very different dimension of gardening can bloom for you even on your windowsill; and you can begin to experience that interspecies affection is the essence not only of gardening but of being alive on the planet at all.

Each role or relationship has its place and labor—farmers to the field, lovers to bed or riverbank . . . And friends? *Shared work* proves the most durable bottle for this wine. Friendships without a shared labor of some kind usually grow thin and die, or remain feebly latent, a possibility glimpsed but not explored or embodied. "Coming to meet" must be followed by the "holding together" of active friendship.

Hold together with clear motive and consistent energy that won't quit. Then the timid get sure. Make friends of neighbors. Offer truth, like a full earthen bowl. Hold on tight to the best in others. Holding together is not just hanging out.

FORGIVENESS: THE GENTLE CENTER OF FRIENDSHIP.

Getting to know bamboo, you quickly get to want to know it better. The only thing that grows as quickly as bamboo is interest in it. This interest propels you to work with bamboo in some way, and working with this Friend you find that work of any significant scale implies working with human friends also—which can be a path to estrangement

unless friends are skillful at fostering a durable relationship. Forgiveness, an ability to make a fresh start, is absolutely basic to this skill, and there is no more accurate measure of our capacity for friendship than our capacity to forgive.

Governments and large corporations have, in general, shown only sporadic interest in bamboo, which yields less rapid return on investment than armaments or automobiles. So immediate bamboo development in the West will depend much on an initial widespread popular concern, groups of people coordinating their creative energies. They must do this not for a week, month, or year, but in a durable manner, tuned to the ample rhythm and nature of bamboo, not to the spastic rhythms of whim or momentary fad. They will often find it necessary to forgive one another a certain maddening resistance to creative union. This resistance to significant union is a nuisance with a thousand faces that is built into us at deep levels of our competitive cultural imprint. It often compels groups to ravel at evening what they weave by day, like Penelope stalling the suitors, but without the steady sanity of her hidden cause.

For the modern West, the social unit is the individual, the supposedly separate, supposedly sacred "I." More traditional cultures generally see our human reality more as a web or relationship, a co-creation with others rather than a piece of Private Property surrounded, psychologically, by a cyclone fence. The *I Ching* is one ancient vision of a fruitful and harmonious inter-survival of the person, friendships, the family, the community, and the state. The sexist and hierarchic "superior man" of Wilhelm's familiar translation we would amend to the "complete person."

SMALL CHANGE.

Complete people fix scenes in their act. Small change adds up. Come home again to the real little world around you. Keep your steps open and watch your eyes.

Complete people are approachable, always ready to share knowledge, without limits of tolerance and care for the people. Yielding, but firm in movement; serious about lightening the inner life; treating the crude gently, crossing the river firmly; neither lost in the distant, nor enmeshed in the near; dwelling in essentials with devotion.

Finish before starting again. Complete people make complete acts. Complete acts make incomplete people complete. But if things grind to a halt don't fight it. Time to breathe, watch. Complete people fall back on their insides to

escape difficulties. Mouth shut, hands active, stomach friendly, mind clear. Sky and earth united, everything flows free. Whoever hears the heart gets home again. Keep up the good mind.

Sun Tzu: The Art of War.

Hard to be soft, but it's the only armor worth wearing for the warrior.
—Buddhist Proverb

The Art of War, said to be composed by Sun Tzu around 400–320 B.C., is the earliest in a long lineage of Eastern classics on the martial arts. It has remained one of the most consulted to the present day, a bedside book of Mao that has deeply influenced both Japanese and Russian military theorists as well. For Sun Tzu, the best war is the one that successful diplomacy makes unnecessary: "To fight a thousand times and win a thousand times is not the blessing of blessings; it's to beat the other fellow without ever getting into the fight." This military version of the gentle art of *wu wei*, "not doing," reflects the same respect for emptiness and receptivity we have seen in oriental philosophy and art. The marrow of war for Sun Tzu, the fluid bones of the battle, is shapelessness—the same flexible emptiness described as the gate to the "wonder realm" in Zen. "Don't repeat a winning tactic. Rather, mold your actions to an infinite variety.

The good general: headquarters with heart.



Samurai such as Miyamoto Musashi staked their lives on their awareness. The buried treasure in his "map of tactics" is a spirit that refuses defeat.



Water takes the shape of ground below it. Design your battle by your enemy. War and water have no constant shape."

THE GOOD GENERAL: HEADQUARTERS WITH HEART.

A crucial character in the art of war is "the good general." He is Sun Tzu's complete person, headquarters with heart.

Sun Tzu finds that the heart of leadership resides in physical solidarity with the led. This opinion departs vigorously from contemporary style, in which all countries, regardless of their political creed, believe firmly in soft couches in their embassies and an impressive limousine to lead the parade. The Minister of Housing is not homeless. The Minister of Agriculture is not hungry. The Minister of Health is not sick without doctor. The Minister of Transport is not hitching or riding a bus. The Minister of Labor is not unemployed. Hard to design a cultural pattern in which the leaders truly experience and remain in touch with the pain and possible exits from pain for the very poor, but here is what the oldest consulted classic of a flourishing contemporary art has to say about opening the third eye of enlightened management:

The good general doesn't think of fame while advancing or of shame in retreat. He only thinks to protect the people. He is anxious as a grandmother for the army, so they will go into the deepest valleys. Thin coats feel warmer at his word. He eats and wears what the troops eat and wear. He doesn't ride if others are walking. He carries his own rations and sleeps on the ground like everyone else.

He doesn't carry an umbrella in the summer, or get more blankets in the snow. When the whole army has water, he drinks. When the food is ready for the whole army, he eats. When all the walls in the camp are built, he thinks of his own roof then.

A map of tactics.

Hard to keep track of the true Way. Small and big, shallow and deep are all part of it. Here's a map like a straight road in front of your feet on the ground.

Words miss the way. You have to feel it in your body, from your heart. Spirit: determined and calm—in crisis or everyday life. Not tense, not reckless. Neither excited nor down in the mouth. To a friend—clear water in the wilderness; and to a foe—invisible.

Big people should know how it feels to be little; little people, how it feels to be big. But don't be fooled by roles or bodies: the open, unleashed spirit, the original energy, sees from above the body, can't be lied to, and stays steady even under stress.

Want to learn the way of strategy? Think about this: the teacher, the needle; the student, the thread. Practice day and night.

Big's easy to spot. Hard to see Small. Big groups move slow, so they're predictable, while one alone can change mind fast. Think about that.

Think honestly. Train in the Way. Know

every art and tools of all trades. Judge spontaneously between profit and loss. See the unseen. Notice trifles. Do nothing useless. Scan on a large scale. The secret of strategy is a spirit which refuses defeat.

Time is in everything, even the void. All things rise and fall. Knowing the rhythm of things, you can strike naturally. Knowing their timing and using surprise timing, aware timing, a void timing—battles are won. Knowing the Way broadly, you see it everywhere: don't die with your weapon idle in your hand.

Masters of strategy know and deploy the people. They know abilities and imitations. Aware of limits, encouraging if necessary, asking nothing unreasonable, passing constantly among the people.

All ways have byways. Small shifts in directions get big. Straying from the Way, your spirit loses it. Look at the world: you'll find People for Sale. Eager to make it, anything for a buck. Somebody once said, "Unripe strategy is a guide to grief." Sure is true.

—Musahi

Miyamoto Musashi.

Miyamoto Musashi, the seventeenth century Japanese sword saint (1584–1645), distilled a life's experience in a brief work composed just before his death, *The Book of the Five Rings*. Musashi is still carefully consulted by executives of Japanese multinational corporations to plot global tactics, and has become a guru to Wall Street strategists as well.

THE EDEN OF EFFORT AND THE EDEN OF EASE. To those disturbed by the basic military metaphor in the Sun Tzu and Musashi material, we would suggest that even for the most nonviolent of all possible pacifists it serves to Know Thy Enemy—if these indeed be such—and salvage from their methods whatever tactical principles can be applied, in an inventive manner, to bloodless, cultural revolution on the planet.

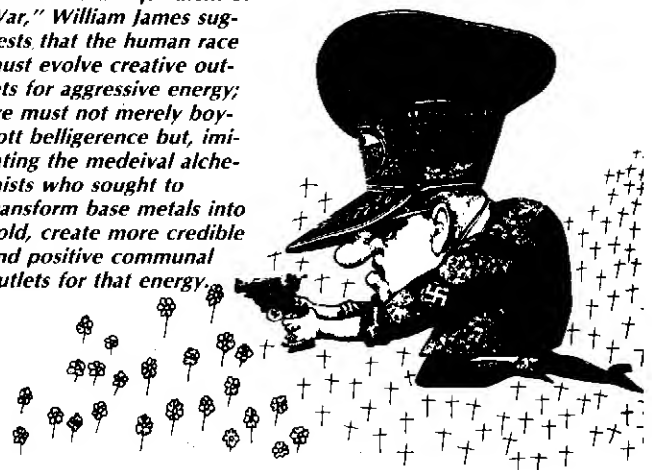
William James, in an essay called "The Moral Equivalent of War," finds struggle so central an aspect of our nature that he believes we can gradually eliminate the gross horror of war from human cultures only by providing creative cultural expressions for its energy that are of equal intensity and magnitude. He suggests an Eden of creative Effort as a more interesting and engaging alternative to the Eden of Ease, the dream of effortless and expanding convenience infecting our late twentieth century Western imagination even more than it did the late

nineteenth century psychology that James possessed and addressed.

Many shrewd people, perhaps correctly, feel it's sentimental to imagine that the Revolution needn't be red. But revolutionary style is itself evolving. A serious global effort could achieve a revolution in revolution design, perhaps, and blueprint a green, ecological revolution in such detail that it occurred. The accurate culture map becomes the territory.

But peace isn't lazy. We must fling ourselves into cultural revolution on the planet with the passion and energy that in the past have been reserved for war. Anything less than the everything of our unleashed capacities is perhaps, at this eleventh

In his "Moral Equivalent of War," William James suggests that the human race must evolve creative outlets for aggressive energy; we must not merely boycott belligerence but, imitating the medieval alchemists who sought to transform base metals into gold, create more credible and positive communal outlets for that energy.



hour, not enough to make a revolution kind to the planet, and mending without blood.

As you read the words of this single sentence, four or five people, mostly children, have died of hunger, and forty or fifty more have been born. There is no place here anymore for people who don't want to share. How can we let them know that, quickly, and without a gun?

REKNOWABLE ENERGY

Cultural meristem.

*Kids are kings in the
kingdom of Change.*

The meristem, or meristematic tissue, of a plant refers to that part where the cells are still capable of division (word root is from Gr. *meristos*, divisible). All tissue can be divided, in our understanding, into three parts: dead, or merely living, or both living and productive of new life. This book is about innovation in culture (Barnett 1953), and so is addressed mainly to the cultural meristem, those still budding, still able to divide clearly in themselves the new from the old, scrutinize their attitudes and acts to see if they proceed from a frozen past or valid and fluid future, from parts of them dying, or from parts being born.

The inward meristem, where we are still breeding, have the innocence to enjoy ourselves and the courage to imagine that people can indeed create their world, is what Carlos Castaneda's holy Yaqui or Yankee hoax, Don Juan, calls "a path with heart," which feeds you every step of the way. At every step of it diverge the paths of phantoms, promising food and the way home, only to mislead you. Whether bamboo be heart or phantom lies in the hand behind the use, in you. But the bamboo path, unlike many, at least has the distinct possibility of heart, health, hearth, wholeness, a durable sanity, a way home.

We are less likely to lose our way on the way by following the true cultural meristem of our children, the budding point of social change. "Give me a lever long enough and place to stand," says Archimedes, "and I'll move the world." The world is moving on its own, but its trajectory is more deflectable than our directors dream. It is up to the people, not to "take charge" in imitation of our "leaders," but to learn the subtle art of nudging their lives and their history in more healing directions than are presently the general issue of the surrounding cultural design.

The long lever we have chosen to nudge the

world is bamboo; the place to stand, child mind, the kingdom of kids.

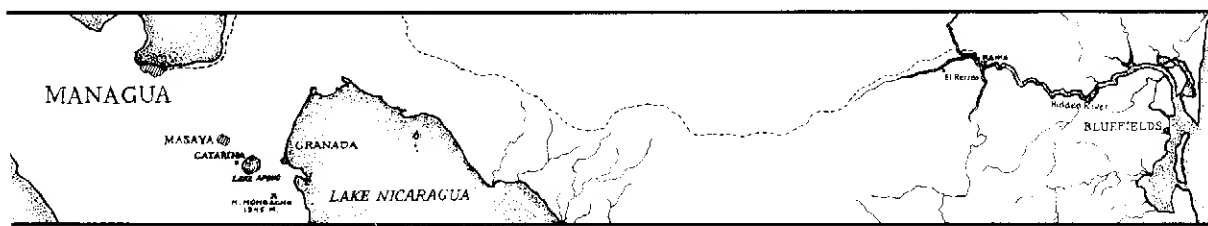
KINDEREDEN: THE OPTIMAL ORPHANAGE. The cry of the global orphan is becoming a huge sound, not to be silenced, on the human doorstep. It seems more promising to regard this as an opportunity than as a problem.

Children of war, abandoned as garbage not worth looting, are in fact the neglected treasure of it, more valuable per acre than any land or resource the enemies could contest. Bucky Fuller computed in the '60s that it would require some 28 city blocks of computers to roughly approximate—never exhaust—the capacities of the human intellect, granddaddy computer stored in each of us, complete with that wondrous capacity to clone—with the help of an opposite equal to our biology.

So orphans can be seen as the chief booty of war, whose value is completely overlooked by the civil idiots who incite, supply, and wage wars to begin with. None or few of them are women, who know what it costs to bear and raise children only to say goodbye forever when the full possibility of their adult being has just begun, only to watch them leave to die for causes requiring ever more cosmetics to appear remotely glorious.

Nations—like the U.S.—that leave a sea of orphans in the wake of their fleets, could do better than erect marbled memorials back home to their wasted sons. A fitter monument to war would be an optimal orphanage, designed to foster the creative vitality of war's youngest victims so effectively that they become bright agents of peace, architects of the higher harmonies that our race must learn soon to erect in its fisty midst if we are to survive at all.

Bamboo for centuries in China was regarded as an optimal godfather. Placing a child under the protective adoption of a grove brought the best of all possible luck—so choosing bamboo as the patron plant of an orphanage seems in complete harmony with its ancient oriental role. We invite residents of the United States especially to participate in this task, because building a bamboo orphanage in Central America in 1984—famous as the date of Orwell's hell—seems an appropriate and durable expression of solidarity with the people of that region, whose death rate and orphan index is considerably heightened at present through United States aid. The most terrible apparent disadvantage is no lid to the original energy of new life, if fostered with alert love and earth awareness. Montessori in a slum of Rome, George Washington Carver with the chil-



dren of poor black farmers and exhausted soil of Alabama, have demonstrated that when ordinary human nature even in its most socially deprived forms is tended at the start in its *learning to learn* (what mainly makes us human) with affectionate and creative use of the methods of science—the miraculous can become the norm.

"The gate of the Great Learning lies in watching, with affection, how the people grow," say the Confucians. The greatest learning treats of the patterns of learning. These are best learned by focusing our lens on our own mirror: human nature in the form of new life, the reknowable energy of child-mind in full flourish of development. "When going into the woods to cut an ax handle, the model is not far off," say the Chinese. Human nature is at our elbow always, but most vibrantly so when we are surrounded and encouraged by new versions of our own creative energy. We have spoken often in these pages of appropriate technology, village technology, or technology "with a human face." Looking more deeply at the aims that direct cultures and define their stature, we could perhaps more accurately divide our human doing into the technology of service and the technology of profits—and pain.

*Peoples' options on the earth are plain:
wander a thousand valleys and you'll find
a million villages, two states of mind—
a state of service and a state of pain.*

—Sufi Proverb

BAMBOO BOX SEAT ON A TINY WAR. Much of this book was composed in a country—Nicaragua—presently under heavy United States economic and military pressure. We were North American *tecnicos*—agricultural technical advisors—working from 1981 to 1983 with the Sandinista Ministries of Agriculture and Education. Our work included harvesting bamboo in groves in Zelaya 30 miles away from where our Cuban counterparts were being killed among their crops by *contras* (counter-revolutionaries) financed by the United States. We were frequently mistaken for Cubans in the small villages; we, too, could be killed by American aid.

One night, bridges suddenly blew up at several

In Nicaragua, groves of elite bamboos exist in El Recreo, Zelaya, an easy float down the Hidden River to Rama, an inland port five days from Miami and New Orleans. Primary bamboo consumption is in Catarina, a basketmaking village in the low mountains south of Managua overlooking Lake Nicaragua. Introducing the best

species of bamboo to the craftsmen most dependent on the plant for their livelihood is a priority in many Latin American countries. El Recreo and Catarina have been chosen as the poles of an experimental project exploring formats for effective bamboo development on a national level in the West.

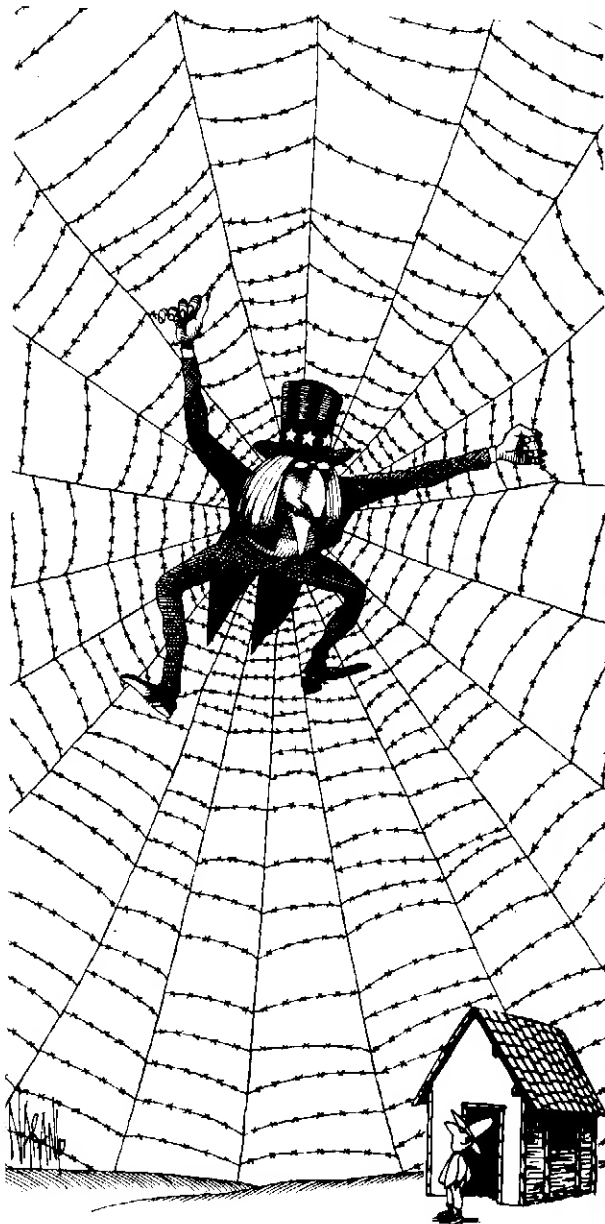
locations in the country, just before a scheduled field trip with our local school in Catarina near Masaya in western Nicaragua, to harvest at the government's collection of elite oriental bamboos in El Recreo, in the east. Preparations for the trip had been going on for three months, budgets submitted to the Ministry of Education, permissions formally secured from the Ministry of Agriculture, the cash, by some miracle, actually in our hands. We woke up, a day before departure, to a national state of emergency; militia or soldiers at all bridges in the country on major roads; the history of U.S. intervention summarized once more in the press; and parents unwilling to have their *muchachos* travel 150 dangerous miles from home to harvest bamboo, in Zelaya, of all places. We stopped trying to get them to distinguish between northern Zelaya, where most of the fighting was, and central Zelaya, where we were going, when the afternoon paper published accounts of the death of Cuban agronomists near the central Zelaya groves. Our work force dwindled from twenty to two.

In El Salvador, we had already found our research surrounded by war: a fresh corpse near the bamboo groves the day we arrived at the experimental station in Santa Ana, some 30 miles northwest of San Salvador, and another shot down on the street as we rode home on the bus. I reached for my camera, and a friend shoved it back in my lap. "Just shoot bamboo. And don't go out after dark. It's still supposedly legal for groups of three people or less, but you may meet a soldier who can't count" (July 1980). But we did go out, sleepless, around 11, and again around 3 A.M., and found all at peace in San Salvador, in our sector, only the

lights of the funeral home burning between the Hotel of Saint Anthony (patron of pigs) and the bus station. The undertakers in Central America have their hands full of money and blood. . . .

We saw enough that it has become a struggle to maintain the orderly voice assumed in these pages. As Tolstoy said a long time ago in the face of equally intolerable outrage, "I cannot keep silent."

I have a scream. But better to sing it, and shape it into durable resistance of botanical activists. Better to keep a small fire burning in prevailing darkness, ready for the chilly children of the coming dawn.



Come without a book or banner.

*In New York, there crooned a concrete siren
tunes that itched in ears across a sea:
"Send me your tears, your foiled and barren,
your thronging masses, longing to be free . . ."*

*Freeways arched above the startled farmer.
Fallout lurked beneath the leaves of grass.
The torch of Freedom in the harbor
was snuffed and shoved, still smoking, up Her
past—*

*So we must act, but in a tranquil manner;
rest, but wakeful to the dream;
come without a book or banner;
how we move is what we mean.*

*Raise the child and weed the garden—
Nature's play is never done.
Praise the wild and free the warden;
cram a carrot up his gun.*

*Pile your bullets taller than a mountain;
pack the bloody oceans in a pail;
but life is not a bucket, but a fountain.
And the truly free are not for sale.*

CHAPTER 10

0. The Fool; Tarot pack adapted from Waite.
1. McClure 1926:1.
2. McClure 1966:vii-viii.
3. Calderon 1980:5.
- 3a. Ibid.: 4-9.
4. Lessard 1980:5.
5. Ibid.: 205-6.
6. Ibid.: 15-8.
7. Ibid.: 57-62.
8. Ibid.: 19-46. Lessard basically summarizes Varmah's (1980) report on bamboo in India, available on request from Dehra Dun.
9. Varmah 1980:22.
10. Lessard 1980:63-8.
11. Ibid.: 91-5.
12. Ibid.: 69-80.
13. Ibid.: 81-4.
14. Kiang 1973.
15. Lessard 1980:85-90.
16. Ibid.: 109.
17. Condensed from the *Journal* of the American Bamboo Society 1980: 1.1:1, "Statement of organization and purpose."
18. USDA Notice of Quarantine No. 34, Oct. 20, 1917. Effective Oct. 1, 1918.
19. Compiled by Higuchi of Kyoto University for the International Union of Forestry Research Organizations in preparation for their 1981 XVIII World Congress in Japan.

GLOSSARY

A

adventitious. occurring in an unusual position, "adventuring." "In the bamboos, and in other grasses as well, the principal complement of roots is adventitious, arising at the nodes of culms and rhizomes, and not from the primordial root." (McClure 1966:296)

aerial. above ground, as in "aerial roots."

albino. white, pale; without or with little chlorophyll.

albo-striatus. white lined.

angustifolius. narrow leaf.

argenteus. silvered.

arundo. reed.

aureus. golden.

auricle. earlike growth; in culm sheaths, a small growth on each side of the ligule (q.v.).

auricomus. golden haired.

axis. the central column of the inflorescence (q.v.). The mainstream and root. (*Oxford English Dictionary* 1971:600)

B

bloom. waxy deposit on new culms, white or blue white, excreted as waterproofing to protect the soft wood of young bamboos.

branch complement. group of branches at culm nodes.

branch sheath. protective covering borne at each node of branches, similar in form and function to culm and rhizome sheaths.

C

caespitose. (L. *caespitosus*, from *caespes*, sod) growing in tufts, or close clumps, as in bamboos with sympodial rhizomes.

calamus. reed.

Chimonobambusa. (Gr. *cheimōn*, winter) a hardy bamboo genus named for its rare habit of shooting in late fall or winter.

chino. of China.

chrysanthus. golden yellow.

circumaxial. around an axis; as a sheath or ring of adventitious roots that completely circles a culm node.

clone. "group of cultivated plants produced vegetatively from one original seedling or stock." (Lawson 1968: 178)

culm. (L. *culmus*, stalk) the stem of a bamboo plant that emerges from the underground rhizome and bears branches.

culm sheath. husklike protective covering attached at each node of culm whose distinctive coloring and shape serves perhaps more than any other organ to distinguish species within a genus of bamboos.

cultivar. "seedling sports from a species which have multiplied from a single clonal source." (Lawson 1968:40) A sport is a plant abnormally departing, especially in form or color, from the parent stock; a spontaneous mutation.

D

deciduous. falling off; shedding leaves annually; also applied to culm sheaths or other organs; the opposite of persistent.

dentate. "toothed"; with toothlike notches.

diaphragm. (Gr. *diaphragma*, a partition wall) the internal division between internodes at each node.

diffuse. (L. *diffusus*, spread out) grove formation when growing with some distance between culms, typical of most temperate monopodial bamboos and those sympodial species with long-necked rhizomes such as *Guadua* species or *Melocanna baccifera*.

distichus. arranged in two rows.

E

edulis. edible.

efflorescence. powdery crust that covers a surface.

erectus. upright, erect.

F

falcatus. sickle-shaped.

fastuosus. bountiful, stately.

fistulose. (L. *fistula*, a pipe) hollow, like culm internodes and branches of most bamboos.

flexuosus. bending, zigzag.

G

geniculate. (L. *geniculatus*, with bended knee) bent at an abrupt angle; zigzag.

giganteus. gigantic; larger than the type.

glabrous. free from hairs; smooth.

glaucous. a dull bluish green, usually with a matt surface.

gramineus. grasslike.

gregarious. (L. *gregarius*, of a flock or herd) simultaneous flowering of a given generation of bamboo plants. (Cf. sporadic.)

H

humilis. of low growth.

I

inflorescence. collective flower of a plant.

intermediary veins. fine veins between secondary veins of leaves, parallel to them.

internode. segment of culm, branch, or rhizome between nodes.

defined form, and solitary or several in a cell; sometimes large enough to almost fill a cell completely ("silica cells") and having a characteristic shape. Some twenty different forms of silica bodies, useful for diagnostic and taxonomic purposes, have been described in the anatomy of grass leaves.

siliceous. containing silica.

Sino-. of China.

spathiflorus. bearing flowers in spathes (that is, one or several flowers within a bract).

sporadic. describes bamboos of a common generation of seeds that flower at different times or irregular intervals: as opposed to gregarious (q.v.).

stoma. (Gr., mouth, opening; pl. stomata) minute mouthlike openings in the epidermis—outer cell layer—that covers photosynthetic tissue. Two "guard cells" shrink or swell by loss or gain in fluid within, thus opening or closing a slit (the stoma) between them.

striatus. marked with fine lines or grooves.

sulcate (L. *sulcatus*, furrowed) grooved; said of culm internodes in which a depression occurs in the surface on alternate sides above the point of attachment of branches—a characteristic of *Phyllostachys* bamboos. Also occurs on branches.

sulcus. (pl., sulci) a groove or depression in internodes of culms or branches. See sulcate.

sulphureus. yellow or sulphur colored.

sympodial. (Gr. *sym*, together; *pous*, *podos*, foot) tropical, clumping bamboo rhizome form. Term coined by McClure (1925)

and generally adopted by later botanists to describe the underground organ giving rise to culms in warmer climates. Later called pachymorph (McClure 1966:24). Distinguished from the monopodial rhizome of temperate bamboos.

tabaschir. (tabasheer) a porous, translucent, milky secretion of silica found in the stems of some tropical bamboos, anciently attributed medicinal and magical properties; "an opal of plant origin" (Jones 1966). Long considered an aphrodisiac in the Orient. Hidalgo (1974:xv) mentions the belief that it cures asthma and coughs.

taxon. (Gr. *taxis*, arrangement) a group of plants (or animals) with common characteristics indicating genetic relationship.

tectus. rooflike.

teratic. (Gr. *teras*, *teratos*, monster, wonder) abnormal, unexpected, deviating from the ordinary form; teratological. Tortoise-shell bamboo, a freak form of *Phyllostachys pubescens*, is one of the better known cases of oriental interest in and even reverence for bamboo's occasional departures from botanic norms.

tessellate. (L. *tessera*, a square piece of marble, glass, and so on used in pavements or walls).

Tessella, its diminutive form, meant "little cube"—a bone, ivory, or wooden die used in gambling. Tessellate means to form mosaic, to lay checker work.

tessellation. "mosaic of small unequal squares or oblongs formed

by crossveins of a leaf." (Lawson 1968: 182)

tillering. (AS. *telger*, a young branch; *tilian* to aim or strive, to work hard for; Dutch, *telen*, to propagate; Gothic, *til*, opportunity; *tils*, opportune, suitable; Old Irish, *dil*, agreeable, pleasant). (Partridge 1958:720) The word is an interesting example of the tillering of language, and the constellation of meanings suggests a more positive attitude towards effort and sweat than is our present norm.)

"Throwing out stems from the base of a stem." (Jackson 1949) "Proliferation of a culm from its basal (subterranean) buds, without the intercalation of a rhizome proper." (McClure 1966:317) (Tilth, a related word: act of tilling, cultivating; cultivated land. Tillage.)

vagans. roving or wandering.

variegation. diversity of color.

venation. arrangement of veins in a leaf.

verticillate. arranged in a whorl, as round a stem.

viridi-glaucescens. bluish green.

viridistriatus. marked or lined with green.

viridus. green.

vittatus. striped longitudinally.

witherings. small, often weak shoots growing at the base of a tree or shrub.

The philosophic glossary.

The complete and philosophic glossary which we have imagined but not compiled would be stuffed as a Christmas turkey with clear graphics and include generous examinations of the roots, where relevant. *Origins*, a short etymological dictionary of modern English, by Eric Partridge (1958), is a fascinating tool for the task. Returning to the roots of experience is a constant theme of the wise of all ages, and returning to the roots of language can give words the freshness of a spring morning for us

again. The roots of *tillering*, above, suggest that the Old Irish and others found it "agreeable" to strive mightily and aim far, with themselves and their fields. It suggests the spirit in which we might till our own capacities. The related Gaelic word, *dil*, meant zealous. (See also the German *Ziel*, aim or goal: what we strive for with zeal.) On asking the wages for his effort as messenger, one of the Old Testament prophets was told by God, "Your wage is your struggle: watch the effort of your soul, and you'll be satisfied."

J

japonicus. of Japan.

L

lanceolate. lance-shaped.

leptomorph. (Gr. *leptos*, thin; *morphe*, form) McClure's term (1966:25) to describe the monopodial, temperate, running bamboo rhizome. (See pachymorph.)

ligule. (L. *ligula*, a little tongue) the projecting rim at the tip of a culm sheath between the auricles on the inner side where the sheath blade is attached.

lumen. (L., opening; pl. lumina) the hollow central cavity of culm, branch, or rhizome.

M

macrospermus. bearing long seeds.

marmoreus. marblelike.

meristem. (Gr. *meristos*, divisible) tissue in which cell division and growth are active or potential.

mitis. gentle, defenceless, without thorns or spines.

monopodial. (Gr. *monos*, one; *podos*, foot) a term coined by McClure (1925) to describe the long rhizome of running, temperate-zone bamboos.

morphology. (Gr. *morphe*, form; *logos*, word or account) study of plant or animal forms.

multiplex. manifold.

N

nanus. dwarf.

niger. black.

nipponicus. of Japan.

nitidus. shining, smooth, or clear.

nobilis. noble or stately.

node. (L. *nodus*, knot) the joint between hollow segments of a culm, branch, or rhizome; the point at which a rigid membrane of vascular bundles lends strength to an axis of bamboo by crossing it from wall to wall.

O

oral setae. the crinkly hairs on auricles of culm sheaths, sometimes

called the shoulder bristles when auricles are absent.

P

pachymorph. (Gr. *pachys*, thick; *morphe*, form) term coined by McClure (1966:24) to designate the squat, short rhizome typical of tropical bamboos. Also called sympodial.

palmatus. lobed; divided into five lobes like a hand.

paniculatus. (L., tufted) having tufts or panicles (pyramidal clusters) of flowers.

parenchyma. (Gr. *parenchein*, to pour in beside) fundamental or ground tissue, such as pith, composed of thin-walled, undifferentiated cells.

persistent. (L. *persists*, remaining in place) not deciduous; said of organs such as culm sheaths that remain in place after fulfilling their function.

Phyllostachys. (Gr. *phyllon*, leaf; *stachys*, spike) commercially important genus of bamboos native to China and Japan.

P.I. "plant introduction." abbreviation used by USDA, prefixed to a permanent identifying number assigned to each lot of living plant material (seeds, plants, or cuttings) accessioned in its record of plant introductions.

pith. spongy cellular tissue in culms and branches.

Poaceae. the grass family.

primordium. (L., the beginning; pl. primordia) an outgrowth—such as a branch or root—in an early dormant state or in its earliest recognizable condition.

proliferation. (L. *proles*, offspring; *fero*, I bear) "Bearing progeny as offshoots" (Jackson 1949). "The rapid multiplication of members of a branch complement by the prompt awakening of buds at the proximal nodes of the component members. The proliferation of the culm itself by the same process (without the intercalation of a rhizome) is called stooling or tillering" (McClure 1966:311).

prophyllum. (L., first leaf; pl. prophylla) a sheath at the first node of a branch; lacks blade, auricles, and ligule.

proximal. (L. *proximus*, nearest) located at or near the base of an axis or organ; basal. The opposite of distal.

puberulus. somewhat downy.

pubescens. hairy or downy.

pumilis. low, little, or dwarfed.

punctatus. marked with dots or spots.

pygmaeus. dwarfed; quite small.

R

ramosus. having many branches.

reticulatus. netted, resembling a network.

rhizome. (Gr. *rhizoma*, a mass of roots) a food-storing branch of the underground system of growth in bamboos from buds of which culms emerge above ground. Popularly known as rootstock, rhizomes are basically of two forms: sympodial (tropical, clumping, pachymorph) and monopodial (temperate, running, leptomorph).

rhizome sheath. husklike protective organ attached basally to each rhizome node.

S

secondary veins. veins on a leaf running from base to tip on both sides of midrib; considerably more prominent than intermediary veins.

septum. (pl. septa) partition or dividing wall of tissue.

sheath. an enveloping organ attached at its base to the nodes of rhizomes, culms, and branches in bamboos, designed to protect the tender tissue during growth. Mid-culm sheaths are valuable identification means for distinguishing species.

shoot. (AS. *sceotan*, to move rapidly) as a noun, signifies a young growing culm, branch, or twig; as a verb, designates the emergence of culms from the ground or branches from the culm.

silica bodies. pieces of silica secreted and remaining within cells of plant tissue, particularly the epidermis or outermost layer of cells. Sometimes small, without

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12. **ARCHITECTURE.** Alexander,* Brett, Buck, Charney, Denyer,* Duly, Engel, H.,* Fathy,* Kern,* Kuehn, Morse,* Neutra, Rudofsky,* Rykwert,* Shelter,* Wilckens, Wright, F. L.

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12. **FORESTRY.** Bene, Brand, Douglas,* Drew, Eckholm, Frazer, Giono,* Medway, Saint Barbe Baker,* Sanger, Sloane, Smith, R.,* Tillman, Weber.

13. **CULTURAL DESIGN.** Chuang Tzu,* Freire, Illich,* McLuhan, Marx, Meggers, Montessori,* Neihardt, Papanek,* Pound, Rothschild, Smith, H. N., Standing,* Sun Tzu,* Tompkins, Wilhelm,* Worcester.*

*Recommended; especially useful.

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15. *Shakuhachi Gaku* (Crown SWS-3).
16. *Escale au Japon* (Pathe CCTZ 240, 763).
17. *Japanese Koto Music* (Lyrichord LLST-7131).
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This list is lifted from Levenson (1974:31-32) with gratitude and small changes. It barely scratches the surface of bamboo recordings.

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DAVID FARRELLY has taught at Washington University, the University of Iowa, and the University of Saskatchewan. For the past ten years he has worked at planting, harvesting, and building with bamboo in rural Mexico, Nicaragua, and throughout the United States. A native of St. Louis, Missouri, Farrelly has worked most recently for the Ministries of Education and Agriculture in Nicaragua.

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